DOCUMENT RESUME

ED 438 977 RC 022 273

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TITLE	UnCommon Knowledge: Projects That Help Middle-School-Age Youth Discover the Science and Mathematics in Everyday Life. Volume One: Hands-On Science Projects.
INSTITUTION	ERIC Clearinghouse on Rural Education and Small Schools, Charleston, WV.; AEL, Inc., Charleston, WV.
SPONS AGENCY	Office of Educational Research and Improvement (ED), Washington, DC.; National Science Foundation, Arlington, VA.
PUB DATE	2000-00-00
NOTE	251p.; For "Volume 2: Hands-On Math Projects," see RC 022 331.
CONTRACT	HRD-9815117; ED-99-CO-0027
AVAILABLE FROM	Full text at Web site: <http://www.ael.org/eric/voices/science.htm>.
PUB TYPE	Guides - Classroom - Teacher (052)
EDRS PRICE	MF01/PC11 Plus Postage.
DESCRIPTORS	*Food; Foods Instruction; *Hands On Science; Microbiology; Middle Schools; *Nutrition; Nutrition Instruction; Plants (Botany); Rural Education; School Community Relationship; *Science Activities; Science Instruction; Womens Education
IDENTIFIERS	Dyes; Folk Medicine; *Food Processing; Herbal Medicine; *Herbs

ABSTRACT

This guide contains hands-on science activities to connect middle-school students to the traditional knowledge of their grandparents and elders. Because girls often lose interest in science at the middle-school level, and because women in some communities (especially in rural areas) are seldom involved in work with an obvious science basis, the activities explore common practices associated with women for generations. The guide has three sections. The first section, "Eyes on Herbs: The Science of Folk Medicine," examines traditional uses of plants for medicines and dyes. Students interview adults in the community about folk remedies, investigate common herbs and plants, research connections between traditional and modern medical treatments, and experiment with natural dyes. The second section, "Food for Thought: The Science of Nutrition", helps students understand dietary recommendations; analyze their eating habits; explore connections among food, nutrition, and culture; decode food labels; and plan for healthy eating. The third section, "The Science of Food Preservation: Crocked Cabbage, Jerked Beef, and Pickled Pigs' Feet" brings together microbiology, chemistry, physics, sociology, politics, and history through various food preservation activities. Students explore pH, osmosis, air pressure, microorganisms, heat, food additives, freezing, dehydration, and fermentation. Each section includes an introduction, cautions, community connections, benefits to learners and communities, ideas for additional projects, readings, leader background information, activity descriptions, handouts, and a 49-item bibliography. (SV)

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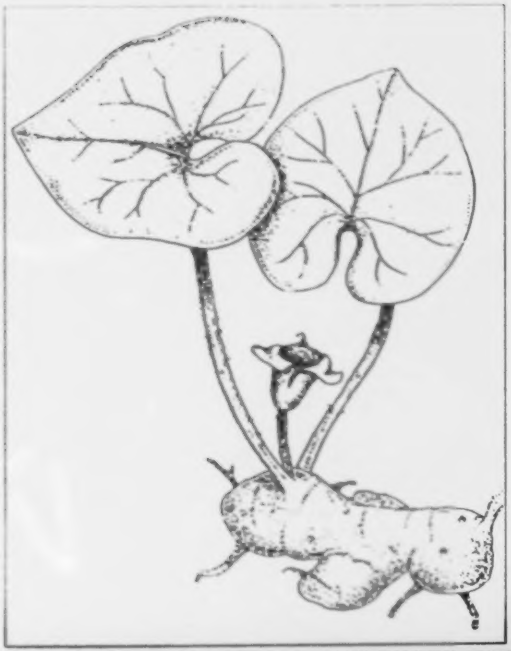

UnCommon Knowledge: Projects That Help Middle-School-Age Youth Discover the Science and Mathematics in Everyday Life

Volume One: Hands-On Science Projects

by Carolyn S. Carter
with Marian Keyes, Patricia S. Kusimo, Crystal Lunsford

RC 022273

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Volume One:
Hands-On Science Projects

by

Carolyn S. Carter

with

Marian Keyes, Patricia S. Kusimo, Crystal Lunsford

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Some illustrations in Guide 4 created by Sara Cohen
Layout design by Carolyn Luzader, Dawn Pauley, and Michael Switzer

This publication was prepared with funding from the National Science Foundation under grant no. HRD-9815117 and with funding from the U.S. Department of Education, Office of Educational Research and Improvement, National Library of Education, under contract ED-99-CO-0027. Other funding was provided by Union Carbide Corporation, Lyondell Chemical Corporation, and AEL, Inc.

Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation, the U.S. Department of Education, AEL, Union Carbide, or Lyondell.

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Preface

You and the young people you work with are about to have an adventure. You will discover treasures growing in a local woods or vacant lot and other treasures living in the skills and memories of grandparents and elders. In a world that seems to value only the most current information and the newest findings in science, it is easy to overlook the value of traditional knowledge. Yet, scientists all over the world have begun to seek out this kind of knowledge as the basis for new research in medicine, agriculture, forestry, and other areas of applied science.

We hope the activities in these guides will inspire youth to learn from and develop new respect for the wisdom of elders so they can carry on this knowledge. In fact, when you finish this adventure, you may no longer consider it remarkable that the human race survived for thousands of years before modern science and medicine.

You will find yourself speaking words you once thought belonged only to people in white coats. It is our hope that some of the youth in your group will get so involved and comfortable with the ideas and concepts in these activities that they will want to continue the adventure. These young people may find themselves signing up for more science and math classes in school—or simply pursuing their own curiosity.

We were especially mindful of girls as we developed these activities because research and experience have shown that too many girls lose interest in science and math at the middle school level. In many communities (especially in rural areas), few women are involved in work that is based on an obvious science or math background. So girls do not have pictures in their minds about possible careers in medicine, research, engineering, or other technological or scientific pursuits. We thought a good place to help girls make connections with science and mathematics might be in exploring some common practices that have been associated with women for many generations. For this reason, we have activities related to quilt designs, food preservation, nutrition, and home health remedies. From this starting point, girls will uncover other uses for science and math.

Although we focused on girls' needs for relevance in studying science, we do not mean to exclude boys. Many boys have enjoyed doing these projects, too. The guides are intended to get you and your group members—girls or boys—involved up to your elbows in the sometimes messy and open-ended problems of science and mathematics in the real world. Encourage youngsters in your group to extend some of the ideas to school science or social studies projects.

We include lots of background information, definitions, and other assistance for adult leaders whose knowledge about science and math may be a little rusty. You should find all the instructions, handouts, and guidance about where to get needed materials (most can be purchased at your local grocery store).

Volume One: Hands-On Science Projects is divided into three sections:

1. *Eyes on Herbs: The Science of Folk Medicine and Natural Dyes* examines traditional uses of plants for medicines and dyes. Learners interview adults about folk remedies, investigate common herbs and plants, research connections between traditional and modern medical treatments, and experiment with natural dyes.
2. *Food for Thought: The Science of Nutrition* helps learners understand dietary recommendations; analyze their eating habits; explore connections among food, nutrition, and culture; decode food labels; and plan for healthy eating.
3. *The Science of Food Preservation: Crocked Cabbage, Jerked Beef, and Pickled Pigs' Feet* brings together microbiology, chemistry, physics, sociology, politics, and history through various food preservation activities. Learners explore pH, osmosis, air pressure, microorganisms, heat, temperature, food additives, freezing, dehydration, fermentation, and other preservation-related topics.

Volume Two has two sections focusing on mathematics:

4. *Pieces of Mine: The Mathematics of Quilting* leads learners into the worlds of planar (plane) geometry, symmetry, and tessellations. Through quilting, learners take a hands-on approach to mathematics, spatial sense, culture, and history. Activities include a symmetry hunt, 2-D geometry with pattern blocks, and designing quilt patterns.
5. *Crafty Mathematician: Making Art through Mathematics* provides mathematical skill-building activities while helping learners understand the mathematics embodied in many craft activities. Learners explore Cartesian coordinates, 2-D and 3-D geometry, measurement, symmetry, and volume; activities include making ornaments, pictures, boxes, and a kaleidoscope.

The guides are based on activities used in Rural and Urban Images: Voices of Girls in Science, Mathematics, and Technology (Voices). Voices was funded by the National Science Foundation and operated by AEL, Inc., an educational research and development organization based in Charleston, West Virginia. This three-year program engaged middle-school-aged girls in the study of science and mathematics in culturally appropriate contexts for southern Appalachia. The program included mentors, an advocacy network, a tutoring program, and monthly workshops.

A 56-minute documentary describes the program and the positive impacts it had on girls of varying abilities, most from rural, low-income circumstances. For a copy of the videotape, *UnCommon Knowledge: The Voices of Girls Documentary*, contact the ERIC Clearinghouse on Rural Education and Small Schools (800-624-9120, e-mail: ericrc@ael.org). An implementation guide will be available in late autumn 2000.

Many people contributed to these project guides. The authors would like to thank the following organizations and people for their assistance, feedback, and contributions.

Sara Cohen, with the Making Connections Program (HRD-9714751)- also funded by the National Science Foundation's Program for Women and Girls- contributed activities and feedback for the *Pieces of Mine* section.

Reviewers, field-test teachers, and workshop leaders provided important ideas and feedback for the units: Theresa Bales, James R. Calhoun, Beth Cipoletti, Ruth Davis, Sonja Davison, Kathi Elkins, Barbara Freeman, Terry Harper, Michael Kees, Wanda Kirschner, Melissa Lovejoy, Mary Martin, Katie McDilda, Julie Lee McQuerrey, Christine Michael, Janine Olian, Kim Poe, Betty Rice, Virginia Rogliano, Robert Seymour, F. Steven Underwood, and reviewers from the Black Diamond Girl Scout Council.

Special thanks to Renee Poe, Carla McClure, Stan Bumgardner, Carolyn Luzader, Dawn Pauley, and Nancy Balow at AEL for their careful preparation of this manuscript. We also wish to express our gratitude to our late friend and colleague Cecilia Thompson, whose careful and good-hearted assistance contributed greatly to the quality of these guides.

Eyes on Herbs

The Science of Folk Medicine and Natural Dyes

Introduction

Are we in danger of losing what our elders knew about health and medicine? How did the makers of carpets and fabrics create colored dyes before we had modern chemistry? In both cases, our ancestors knew how to use the chemical compounds that naturally occur in many plants. In this project, young people will become researchers, by . . .

- preserving medical folklore
- learning the scientific basis for some old-time remedies
- discovering how herbs, spices, and plants are used to promote health and make natural dyes, and how they have affected history
- developing recipes for natural dyes, using various plants
- exploring topics such as conservation, health, and the environment

The activities in this project help learners sharpen their critical-thinking, problem-solving, and research skills. Such skills are useful in daily life as well as in science. They will also learn about many useful plants.

Learners talk to parents, grandparents, and other older people to collect information about old-time cures. Books and the Internet help young researchers find links between traditional and modern medicine. They also study common grocery store remedies, make their own "medicine bags," and use herbs for dyes.

Young people may be surprised to learn that most prescription drugs have origins in plants. For example, humans first used the chemicals that make aspirin work by chewing willow bark. Old cures such as belladonna and digitalis led to some modern ways to treat heart problems. Today's doctors are also interested in black cohosh, an herb with plant-based *estrogen*, for use in women's health.

Learners will become aware of how times have changed. Many old-time healers were wisewomen. The herbal methods they used were often quite successful. Today there are many jobs that involve the study of old-time uses of plants. Some lead to high-paying careers, such as *medical anthropology*, *ethnobotany*, and

< Definition

Estrogen refers to an entire class of steroids or hormones. People often think of estrogen as a female hormone; however, males also have some estrogens in much smaller amounts. Estrogens are important in maturation and sexual functioning. They help protect the body from heart disease and osteoporosis.

ethnopharmacology. Other related careers include pharmacy, *horticulture*, and forestry. Many areas of chemistry study old-time remedies, as well.

A study of herbs, folk medicine, and dyeing brings together past, present, and future. By exploring their community, learners often gain respect for their own culture and place. Their work can have lasting effects in their community. By exploring uses of plants in other parts of the world, they also learn to respect other places and cultures.

< Definitions

Ethnobotany is the study of relationships between people and plants. Ethnobotanists study what native peoples know about the plants in their environment, particularly native uses of plants. They may study uses of plants as medicines, foods, dyes, fibers, and building materials.

Ethnopharmacology is a field that explores native uses of plants for healing.

Horticulture is the science of growing fruits, vegetables, and ornamental plants.

Medical anthropology explores how various cultures view and practice health, illness, and health care. Medical anthropologists study many topics from biological, cultural, social, and psychological perspectives.[1]

Cautions

Much is known about herbs, plants, and folk remedies. But people debate the value of this knowledge, with different groups making different claims. Of course, competing claims are part of most real-life choices. There is often no single best answer to any medical question. You can help learners sort through competing claims and decide which information is the most reliable. Some good reference books and Web sites are listed at the end of Activity 3.

This project does not promote the use of any particular medicines, herbs, or drugs. But it can help learners honor folk knowledge and see the links between traditional and modern medicine. It introduces them to field research and teaches them to collect and study data.

Many medical treatments (both folk and modern) help people become healthier. But many treatments do not. In this project, learners do their own research and analysis. They also see that using a scientific approach to making choices is a part of everyday life, not just something done in labs. They learn that being a smart consumer requires critically examining evidence to reach good decisions.

Community Connections

To keep these activities connected to your own community, visit local herb stores, farms, greenhouses, nurseries, alternative medical facilities, parks and forests, hospitals, and/or pharmacies. Invite people who work in these places to meet with your group and talk about their jobs. (Some examples are *holistic* medical practitioners, agricultural extension agents, natural resources officials, herbalists, and farmers.) Many agencies give free or low-cost information on local plant resources, and learners can improve writing and communications skills by contacting

< Definition

Holistic medicine treats the whole person, both the mind and the body.

them. Some possible agencies to contact are the state departments of agriculture, natural resources, or forestry. You may also want to arrange for young people to interview older people living in a nursing home.

Activities: Brief Descriptions

This project has five activities:

Activity 1: Preserving the Wisdom of Our Elders. Learn about folk remedies and local culture by interviewing community members and analyzing data.

Activity 2: Exploring Herbs and Plants. Just what is fennel? Or garlic? Learners taste, touch, or use a variety of herbs and plant products to learn firsthand of their properties.

Activity 3: What Would Go into My Medicine Bag? Make an herbal medicine bag and talk about what such a bag might look like in other times and places.

Activity 4: Color My World: Natural Dyes from Plants. Dye eggs and/or clothing items using natural dyes, explore pigments through simple *chromatography*, and experiment with natural dyes and pigments. You can even create a dye recipe book!

Activity 5: Connections: Science and Traditional Knowledge. Develop a presentation (report, photo or slide display, computer presentation, Web page) on some aspect of folk medicine.

< Definitions

Chromatography is the process in which a chemical mixture is separated into different parts.

A note about materials. You can get most of the materials needed for all activities at grocery stores. For Activity 4, you can buy materials from the store or gather them from natural areas. (Make sure you have permission before collecting plants!) A list of materials is included with each activity. The Materials Summary (page 1-32) lists everything needed in the unit.

Why Study Uses of Herbs?

Benefits to Learners

Young people can gain valuable skills and knowledge by completing this project.

Skills. This project helps learners develop skills they can use throughout life:

- collecting and analyzing data
- making observations
- organizing information
- using evidence and models

- evaluating information
- using the Internet and/or the library to find information
- applying knowledge about health and wellness
- communicating with and interviewing others
- designing presentations

Topics and concepts. Learners gain knowledge that helps them better understand science and history:

- herbal lore
- history of medicine
- properties of various herbs
- relationships between conservation and modern medicine
- economic impacts of plants through history
- pigments, dyes, and *mordants*

Career links. Talk about careers such as herb farming, botanical illustration, medical anthropology, ethnopharmacology, ethnobotany, botany, forestry, horticulture, chemistry, medicine, pharmacology, and various health-related fields. You can help young people see connections between what they are learning and how it might relate to various occupations.

Mordants are chemicals that fix a dye in a fabric or other material by combining with the dye to form a compound that cannot be dissolved in a liquid.

Compliance with National Standards for Science. The topics and skills that young people use and sharpen in this project reflect several of the National Standards for Science at the middle/junior high level. At a minimum, students engaged in the project will address these standards:

Content Standard A: Science as Inquiry
- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

Content Standard C: Life Science
- Structure and function in living systems

Content Standard F: Science in Personal and Social Perspectives
- Personal health
- Populations, resources, and environments
- Risks and benefits
- Science and technology in society

Content Standard G: History and Nature of Science
- Science as a human endeavor
- Nature of science
- History of science

Benefits to the Community

With all the recent scientific discoveries about health, why should we study folk remedies and medicine? Here are just a few reasons:

- All societies have practiced folk medicine. A study of local knowledge gives learners a basis for appreciating the rich knowledge and cultures of their own place as well as those of other people and places.
- Folk medicine honors tradition. Older women and men are sources of wisdom.
- Youth will learn the value of local plants. This will help them understand the importance of conservation and preservation.
- Data collection preserves old ways and teaches life skills. Learners hear stories of life in the past and gain respect for the wisdom of older people.
- Folk medicine is place-based. Learners study local biology and use local resources.

Ideas for Additional Projects

This project also connects with other areas of study. It uses social studies, history, language arts, health, technology, library skills, environmental studies, geography, earth sciences, art, and life skills.

For example, learners may find that some plants used in folk medicine and dyeing harm the environment. They are called "invasive." More than 4,000 species of exotic plants infest more than 100 million acres in the United States.[2] Their range gets 8-20% bigger each year.[3] Almost 400 of these species threaten native plants and animals.[4] Forty-two percent of endangered and threatened species in the United States are in trouble as a result of invading plants and animals.[5] Most *invasive species* came from Europe or Eurasia. They arrived with early settlers, who brought the plants to their new homes for cooking, medicine, or dyes. Or they brought seeds, livestock fodder, and packing materials that were contaminated.

< Definition

Invasive species are nonlocal species whose introduction into an ecosystem causes economic or environmental harm or harm to human health.[6]

You may wish to have your group do some of the following activities to explore geography:

- look at traditional and current growth ranges for certain herbs
- map the growth ranges of a variety of herbs
- use climate patterns and data about global warming to predict future growth ranges of selected herbs
- use state and/or local data on endangered plants and land use to make maps of areas in need of conservation efforts
- research efforts to control invasive plants in your local area

Find resources for these topics on the Internet using *search engines* such as Alta Vista. Because there are thousands of possible links, focus on what you need by using the "refine" or "advanced" feature of your search engine.

< Definition

A **search engine** is a software tool that lets you search the Internet for information. Common search engines include AltaVista, WebCrawler, Hotbot, Infoseek, and Excite.

Herb Garden

Develop an herb garden. Most kitchen herbs can be grown directly from seeds planted in early spring. Plants such as sage and rosemary are best grown from stem cuttings. Others, like garlic or onion, grow best from bulbs. If you have outdoor garden space, you can grow many herbs in a small area, but many herbs can be grown easily indoors. Dill, parsley, chives, basil, many peppers, coriander, thyme, various mints, oregano, rosemary, and chervil are herbs that can do well indoors. Garlic, fennel, celery, caraway, and sage generally do best outside. You can get indoor herb pots and herb gardens in stores. Or you can visit a local nursery or farmers' market to learn firsthand about growing herbs in your area. There is information about growing herbs on the Internet. You can use many grocery store foods to start new plants. Pineapple cuttings, orange or grapefruit seeds, sweet potato tubers, bean sprouts, alfalfa sprouts, and garlic cloves all produce plants easily. But many of these plants will not live long indoors.

Learners can also start their own business by advertising and selling their herbs. This will teach them about markets and help them develop financial skills. Other ideas include studying herb preservation or performing community service by giving herbs to a local charity or food bank.

Dyes for Craft and Culture

Youth will learn to use mordants and dyes. Then they can dye articles as gifts or holiday decorations. Or they can make and talk about their own *mendhi* designs. These are made on paper using markers or crayons. Learners can also research hair dye, tattoos, and other natural products people use to change the way they look.

Exploring Natural Selection

You can use Activity 4 to help explain questions about natural selection. Why do plants contain pigments? Why do some plants produce colorful flowers and fruits? How have blooming plants changed birds and insects? How might certain plants be used to treat some human and animal ailments?

< Definition

Mendhi is the ancient Indian art of hand dyeing.

Science/Social Studies Projects

Activities in this guide can spark ideas for science, social studies, health, or culture fair projects. Learners may ask more about the workings of certain herbs. They may want to know how to make colors with natural dyes. Both leaders and learners should keep lists of questions to use for further research.

Readings for Young People

Let your learners know about the many books for young people that deal with herbal medicines, plants, and dyes. Books add interest, provide background information, and build literacy skills. See the list below.

The Bridge Dancers by Carol Saller (Gerald Talifero, illustrator). Ages 9-12. Minneapolis: Carolhoda Books, 1991.

The Only Way Out by Deborah Kent. Ages 9-12. New York: Scholastic, 1997.

The Healing of Texas Jake by Phyllis Reynolds Naylor (Alan Daniel, illustrator). Ages 9-12. New York: Antheneum Books for Young Readers, 1997.

Song of the Seven Herbs by Walking Night Bear (Stan Padilla, illustrator). Ages 9-12. Nevada City, CA: Gold Circle Productions, 1987.

Strega Nona: Her Story As Told to Tomie De Paola by Tomie De Paola (illustrator). Ages 4-8. New York: G. P. Putnam's, 1996.

Clara and the Hoodoo Man by Elizabeth Partridge. Ages 9-12. New York: Dutton Children's Books, 1996.

Healing Warrior: A Story about Sister Elizabeth Kenny by Emily Crofford (Steve Michaels, illustrator). Ages 4-8. Minneapolis: Carolrhoda, 1989.

Alternative Medicine: Cures or Myths? by Howard Facklam. Ages: young adults. New York: Twenty-First Century Books, 1996.

Vegetables & Herbs (All About Food Series) by Cecilia Fitzsimmons. Ages 9-10. Parsippany, NJ: Silver Burdette Press, 1996.

Leader Background Information

Herbs and Healing

The term *herb* does not mean the same thing to everyone. To a botanist, *herbs* are plants that do not have woody stems and die down to the ground at the end of their growing season. We will use the broader definition used in medicine that defines an "herb" as any plant species. In their research, learners may find both meanings used.

Every society has used some kind of herbal care. There are signs that *Neanderthals* used plants as remedies.[7] Some animals also use plants as medicine.[8]

Written records about herbs go back thousands of years. Old religious books like the Torah, the Bible, and the Rig Veda talk of herbs used for healing. Ancient Sumerians, Egyptians, Hebrews,

< Definition

The **Neanderthal** is an extinct hominid species that lived at the same time as early humans in Europe, northern Africa, and Asia. We do not know for sure if they are related to humans.

and Indians all wrote about medicine. In Egypt the Papyrus Ebers, written in 1500 B.C., notes more than 700 remedies, including aloe and garlic.[9] The Old Testament book of Ezekiel says that "the fruit of the tree is for man's meat, and the leaves for man's medicine." The Koran talks about the healing power of honey.

People in India and China have long used herbal remedies. The Indian *Ayurvedic* way of medicine, which is more than 2,000 years old, focuses on health rather than curing illness.[10] It uses herbs to balance body and mind. This Indian tradition uses diet, herbal remedies, *meditation, aromatherapy*, music, and *yoga*.

Traditional Chinese medicine is more than 3,500 years old. It links human health to nature and the universe. According to this tradition, the body contains vital energy called *chi* (pronounced *chee*), which depends on the opposite forces of yin and yang. Illness upsets the balance of yin and yang. Herbal medicine, acupuncture, diet and nutrition, and Tai Chi (a system of breathing and movement) are traditional Chinese ways of healing. In traditional Chinese medicine, it is believed that the herb ginseng prolongs life.

< Definitions

Ayurveda teaches that your own body tells you how to eat right and have a healthy lifestyle.

Meditation uses contemplation, prayer, or spiritual study.

Aromatherapy uses fragrant oils from plants to help mood and health.

Yoga is a way of exercise that helps both body and mind.

The first European book on herbs, *De Materia Medica*, was written in the first century A.D. It lists more than 500 healing plants and was widely used until the 1600s.[11] Arab doctors of the eighth to eleventh centuries began what would become the basis of modern medicine. Their books were used for many years. They kept alive Greek and Roman ideas lost in Europe.[12] European monks saved much old knowledge by hand copying books and growing herb gardens.[13] Local wisewomen kept folk learning alive with old herbal cures and "spells." As you can see, herbal care was alive and well in Europe through history up to the seventeenth century. The use of herbal remedies fell with the rise of chemistry and physical sciences beginning in the seventeenth and eighteenth centuries.

Each part of Europe had its own herbal customs. There was no one way of doing things. Europeans who came to North America could not always grow the healing plants of their homelands, but they learned from and shared knowledge with American Indians. Many North American folkways mix American Indian and other traditions. In many places (like New Orleans), people from various cultures have mixed together. In these places, local cures may be mixtures of North American, European, African, South American, and Asian folk remedies.

People from different places have used herbs in similar ways. Both Asian and some Native American tribes used black walnut bark to get rid of worms. The Chinese used it to kill tapeworm, and many cultures used it to kill ringworm.[14] The bark contains *tannin*, which many people knew to be useful. Uses for tannin may have been discovered very early in history and passed along from one group of people to the next, or it may have been discovered again and again by different people in different places.

Garlic was grown in Egypt for more than 5,000 years.[15] Many cultures saw it as a wonder drug. It could treat infections, help prevent heart disease and cancer, and build up the immune system. Garlic contains natural *antibiotics*. Today, doctors use it to reduce cholesterol, lower blood pressure, and slow some tumor growth.[16]

< Definition

Tannin, a substance found in some plants, is used in tanning, dyeing, and to make ink. It also has medicinal uses.

Antibiotics are chemicals used to inhibit or destroy microorganisms.

Fennel, another popular herb, came from the Mediterranean. Romans thought it was sacred and they carried it throughout the world. Ancient people used fennel to kill parasites and to treat arthritis. Today, fennel is mostly used in cooking and as a breath freshener.

Natural Dyes

In many cultures, herbal healers were also dyers. Many plants used in herbal medicine were used in dyeing cloth, reeds, porcupine quills, wool, and other materials. Some plants were used as both dyes and remedies. Some include chamomile, black walnut, many berries, sassafras, dandelion, goldenrod, parsley, mullein, St. John's wort, hickory nut, sage, and coneflower. In early Ireland, dyeing was mystical, full of myths and traditions.[17] For example, dyeing was women's work and men were not allowed in the house while it was being done. Certain days or weeks were considered best for dyeing. Wearing clothes of certain colors was believed to either invite or keep away evil spirits.

It is easy to see why dyes and dyeing inspired such tales. Plants can produce pigments that are very different from the colors of the plant. Although most leaves are green, they really contain a mixture of pigments. In many plants, the other pigments are hidden by the green of chlorophyll. Leaves change color in the fall because the chlorophyll breaks down, letting us "magically" see the other pigments.

Pigments have been used since the Stone Age. Our ancestors were using natural colors 30,000 years ago.[18] Synthetic dyes were developed in the 1850s. Until then, colors came from all-natural sources such as plants, animals, insects, and minerals.

Ancient Egyptians used madder weeds, which grow wild in the Middle East, to dye textiles. Madder, once the most important dye plant in the world, produces a red dye that was highly prized for thousands of years. Mummies have been found wrapped in cloth dyed with the madder plant. There is a legend that the madder plant helped Alexander the Great defeat an army. He is said to have put red dye on his own men so the other army would think they were injured. This red dye was most likely the juice of the madder plant.[19] The feared British "Red Coats" of the Revolutionary War wore coats dyed with madder root.

Indigo has been used for more than 4,000 years.[20] Before the Romans took over the area now known as England, a people called the Picts lived there. To make people fear them, the Picts painted and tattooed themselves with indigo, a blue dye made from bacteria acting on the woad plant.[21] The way the Picts used dye made a lasting impact. The Latin term for Briton, where they lived, means "painted men." The woad plant may have even given medical help to the Picts. In Asia, woad is an antibiotic with a wide range of uses.

Jewish scripture often mentions dyes. Joseph, a famous figure in the Torah and Bible, was sold into slavery by his brothers. They were jealous that their father had given Joseph a "coat of many colors." Dyeing was expensive and took a long time, so a many-colored coat was a mark of high favor. Some dyes, such as those from snails that produce deep shades of purple, cost so much that purple became known as the color of royalty. Likewise, the term *blue-blooded,* which refers to rich people, may have come from the high cost of making dark blue robes. Ordinary people used easier-to-make colors.

Dyes are still important all over the world. Many Native American tribes have complex systems of dyes. In Burkina Faso, a country in West Africa, more than 200 local plants are used in dyeing.[22] The country Brazil was named for the brasil tree, which produces a bright red dye. In Indonesia and Africa, *Batik* is a high art form. Even though this art was developed long ago in ancient Sumeria, it is vital to Indonesia's culture and economy today.

< Definition

Batik is a way of painting designs on a fabric with melted wax, dyeing the fabric, and repeating the process until the desired design is produced.

Spanish and English explorers fought to win the trade in cochineal. This dye, which produces scarlet-to-purple colors, is made from insects that eat prickly-pear cactus. Because many people long ago wanted new, exotic dyes, many trade routes were set up. Some areas attracted a lot of business because of their plants. Northern Italy became a dyeing center because purple dye was discovered in a local species of lichen. Dyeing required so much practice and skill that dyers often mastered one particular color. Dyeing was a key source of income for some communities. By the Middle Ages, dyeing had become a profession. Guilds were formed to protect trade secrets.

Mendhi (also spelled Mehendi or Mehndi) is the ancient Indian art of hand dyeing. It is also the Indian name for the shrub-like plant known as henna. Mendhi began in Egypt and the Middle East. When the Muslims brought it to India in the 1100s, it became an important part of their tradition.[23] The mendhi plant grows in hot, dry climates. It produces a reddish-orange dye that has been used to color skin, hair, and nails for thousands of years.[24] After mendhi leaves are dried, finely ground, and filtered, they are mixed with oil and other liquids to make a paste. The paste is put on the skin in complex patterns. These designs mark special events such as weddings. Mendhi has recently become very popular in the United States. Celebrities with mendhi tattoos have brought the tradition to the nation's attention.

Natural dyes have been used for thousands of years, but they have some drawbacks. They take a lot of time and money to make. Colors can change from season to season. Natural conditions such as weather can cause pigments to be different. The first dye that did not depend on plants for color was produced from coal tar in 1856. These synthetic dyes quickly became popular. By 1880 you could get synthetic dyes in even the most remote towns and villages in the United States. Dye-making methods and traditions that had been handed down for generations were lost. Farm production of many of the plants used in dyeing stopped.

Today more and more people are interested in traditional methods of dyeing. Why is this? Synthetic dyes made from coal tar may harm our health and the environment. Many of them contain *carcinogens*. They have been outlawed in some countries. Some dye-makers use natural dyes for other reasons. For example, natural dyes provide a link to history, culture, and nature. Natural dyes can also look better than synthetic dyes. Synthetic dyes can produce "pure" colors, but most plants contain mixtures of pigments. So natural dyes are often more muted than synthetics. Although both natural and synthetic dyes fade over time, natural dyes tend to fade to a pleasing blend of pigments. Synthetic dyes tend to fade to a less pleasing washed-out look.

< Definition

Carcinogens are substances that can cause cancer.

While some people use natural dyes to protect the environment, even natural dyes can sometimes cause harm. Woad, for example, is used to produce the blue pigment that was used by the Picts. It is a strong plant than can be easily grown in most areas, but it can also be a quick-spreading, hard-to-control, harmful weed.[25] Purple loosestrife, another plant used for natural dyeing, is called the "beautiful killer." It is highly invasive and quickly destroys wetlands. Purple loosestrife was brought to North America in the early 1800s. Since then, it has spread across the country, killing native vegetation and threatening endangered plants. It has also reduced food and shelter for wildlife.[26] Some plants used for dyeing are endangered or threatened species. Collecting them can bring about their end more quickly.

Both natural and synthetic dyes can affect the environment in other ways. Most dyes need *mordants* in order to keep their color. Mordants help keep dyes from fading. They may brighten, deepen, or dull a color. The actual color of a dyed object often depends on several factors: the dye; the mordant; the *pH* of the dye solution; and whether the mordant is used before, during, or after dyeing (see the project guide *"Crocked Cabbage ..."* for activities on pH). By using different mordants, you can get a large range of colors from the same dye. Most commercial mordants are metal salts such as iron sulfate, tin, chrome, copper sulfate, cream of tartar, and alum. Most of

< Definition

pH is a measure of acidity.

these are toxic, must be used with care, and may be environmentally harmful to make or dispose of after use. Natural mordants include acidic materials such as currants or blueberries, dock root, birch, black oak, iron oxides, cedar bark ashes, fir-club moss, and stale urine. Most natural dyeing methods use acidic mordants, alum, or cream of tartar.

In the mordanting process, the item being dyed usually has to absorb the mordant solution. Then the item is dipped in a bath made with ammonia. The ammonia reacts with the metallic salt or acid. This forms an insoluble compound on the material. When the item is dyed, the compound formed between the ammonia and metallic salt reacts with the dye solution. This produces stable, insoluble compounds. The chemistry behind various dyeing traditions is complex and represents hundreds of years of testing.

Dyeing is used all over the world. Science is not just a creation of Western culture. Every culture has used careful, thoughtful research to produce knowledge. We can see their wisdom in activities such as dyeing.

Activity 1

Preserving the Wisdom of Our Elders

Leader Notes

The Traditional Knowledge Interview helps young people learn about traditional medicine from their own community. By talking with older people, youth develop communication skills and gain greater respect for the wisdom and experience of elders. They also learn a lot about local history and culture. Additionally, as they collect information about old remedies used for some common complaints, they build research skills. They study the data they gather and learn how to classify it. Later they will share their findings with the community. These research skills can help them become valuable local resources. Their work can help the community understand its heritage, its resources, and the need for preservation.

Key Questions

- What medical treatments or recipes for health did our ancestors use?
- What plants that grow in our community have medicinal uses?
- What can the traditional medical knowledge of people in my community teach others?
- What can modern science teach people in my community about traditional medical treatments?
- What can we do to preserve medically or economically important plants in our community?
- What can I do to help preserve what people in our community know about its natural resources and their uses?

Traditional Knowledge Interviews

The Traditional Knowledge Interview form (Handout 1-1) helps learners organize and record their interviews. You may want

Materials Checklist

☐ Copies of the "Traditional Knowledge" interview form (Handout 1-1) (1 for each interview to be conducted)

☐ Clipboard or notebook to serve as a writing surface

☐ Pens and pencils to record data

☐ Flip chart pad, posters, etc., to be used in data analysis phase

☐ Copies of "Functions of Various Herbs" (Handout 1-2) (optional—1 per learner or group)

Approximate Time Required

Conducting introductory activities: herb store, natural healer, farmers' market visit, guest speakers, 1-2 hours

Showing segments from the film *Medicine Man*. This film nicely sets the stage for folk medicine activities. However, some of the laboratory procedures portrayed are not technically correct, 20 minutes to 2 hours. (optional)

Preparing learners to do interviews, practicing interview skills/planning on uses for information, 1.5 hours

Conducting interviews, 3 hours (may be done outside program time)

Collating and sorting data, 2 hours

Analyzing data, 2 hours, if work is divided among group

Reporting data, 1-15 hours (Note: Text or oral presentations take less time; creating Web pages, televised reports, slick booklets, etc., takes more time but can reach a broader audience.)

learners to talk to groups of people: the elderly in nursing homes or senior centers, pharmacists, herbalists, doctors, holistic medicine practitioners, or botanists. You might ask some of these people to visit your group or class to share information about their jobs. Learners can interview their parents, grandparents, and other community members.

Preparing to Collect Data

Start by telling learners about their role as researchers. Tell them that over the next several days, they will each be talking to a number of people about folk remedies. Older adults are likely sources: grandmothers, grandfathers, aunts, cousins, and friendly neighbors. Then the group will collect, analyze, and present their findings. Give each learner several copies of the Traditional Knowledge Interview form (Handout 1-1). Go over the "Directions for Interviewer" section. Decide as a group whom to talk with and the best way to get them to talk. Learners can make guesses about what different kinds of things people might say. Help them consider whether these differences have to do with age, gender, ethnic background, or some other trait.

Go over each item on the Traditional Knowledge Interview form. Encourage learners to take notes as they listen to people they interview. They can use the front or back of the form. Tell them that getting complete answers is very important. For example, "use oatmeal" is not a helpful response to a question about poison ivy remedies. You don't know whether to put it on the skin, eat it, or plant it! Also, decide whether to collect data about items that are not listed on the form. If someone talks about a home remedy for hiccups (an item that is not on the interview form), should learners record it or not? The answer is up to you and your group, but make sure everyone in the group understands what to do.

Environmental Note

Recycle papers when activity is complete.

What to Do in Advance

- ☐ Read "Leader Background Information—Herbs and Healing," page 1-7.
- ☐ Arrange for any field trips or visitors. For example, if learners are to collect data in a nursing home, arrange for the activity.
- ☐ Copy Traditional Knowledge Interview forms.
- ☐ Arrange access to dictionaries and other reference materials for data analysis.

Safety Notes

1. Learners may talk to older people in their community outside of group meetings or classrooms. Take steps to make sure learners are safe and well supervised. Make sure that parents know learners may be talking to unfamiliar adults. Parents can even be part of the interview process.
2. Emphasize to learners that remedies may be neither safe nor effective. They should never try the remedies they collect without the guidance of a trusted adult or medical professional.

Planning for Contributing to the Community

Talk about how to use your findings. Will your group do a story for the local newspaper? A story for television? A presentation for a school open house? Possibilities abound, but it's a good idea to decide up front. Some people who are interviewed will want to know what is to be done with the results. Learners should be able to tell them that the information will be reported back to them in some form.

Conducting Interviews

Getting young people ready to do interviews is a great teaching opportunity in itself. Interviews are about getting good data. The atmosphere can be as important as the questions asked. Learners are more likely to get good responses when they set up interviews at a convenient time in a comfortable place. They should put the other person at ease, eliminate distractions, and listen closely. Some elderly people don't hear well, so interviewers need to find a quiet place. They should also allow plenty of time. Encourage them to be polite and to thank people who talk with them. Learners should practice on one another before the real interviews.

Sorting and Analyzing Data

After the interviews, the group must sort and study the data. This is an important learning opportunity. Sorting and classifying information is a valuable skill. If you have more than six or seven learners, you will probably find it easier to divide them into small groups.

The first step is to sort responses by type of illness. You can show the group how to do this, or you can let them discover for themselves an efficient way to do it. The strategy may depend on the group size. Here are some methods of sorting data:

- Have a recorder write down responses as they are read.
- Tape on the wall a large sheet of paper labeled with each illness; have interviewers transfer remedies from their interview forms to the large sheets.
- Develop a response sheet for each question and pass it around so interviewers can write down the remedies they collected.

One group might obtain the following raw data:

Acne Remedies

1. Damp baking soda
2. Lotion
3. Aloe
4. Alcohol
5. Witch Hazel
6. Avoid fried foods
7. Apply baby urine
8. Take a penny on the first day of spring, rub it in the grass dew, then on your face.

As you can see, it is important to remind learners that data must be descriptive! The data they gather should tell others exactly how the remedy works. In the above list, it is not clear that most of the remedies should be applied to the acne, not eaten. This illustrates why it is important to collect complete information.

Next, help learners sort the data to eliminate duplicate information. Then look for working relationships among remedies and divide them into categories. Handout 1-2 and a dictionary may be helpful in finding relationships. The following table is one way of grouping. Many other ways are possible.

Acne Remedies—Possible Functions

- Astringents:
  - Bistort root
  - Witch Hazel
- Antibacterial:
  - Alcohol
  - Urine
  - Aloe
- Drying or "anti-oil" agents:
  - Baking soda
  - Alcohol
  - Avoidance of fried foods
- Demulcents:
  - Lotion
  - Aloe
- Other:

There are many ways to do this grouping. Functions often overlap. One substance may fit into more than one category. For example, urine may have several properties that make it useful in treating acne or other skin problems.[27] There is often no one "correct" grouping. But this exercise helps learners understand that different substances have different properties that are based on their chemical makeup. These properties may offer clues about possible uses for these substances. Learners can then make informed guesses about other substances that might be useful remedies.

This process gives you a chance to correct mistaken ideas about safety and first aid information. For example, the old advice that you should put butter on burns is likely to turn up in the data. However, this is a case where folk wisdom is wrong. Cold water is the best immediate treatment for small burns. Many folk remedies may not work. Some may be harmful. The same can be true of modern medical treatments. This is a good place to point out that medical knowledge changes over time.

Learners may need to study properties of some herbs before they can make groupings. They may also find links between remedies found in their interviews and current accepted medical practice. Refer them to the books and Web sites listed in Handouts 5-1 and 5-2 to begin their research.

Reporting Data

Learners can report their findings in a variety of formats. Here are a few ideas:

- newspaper article
- television story or video
- presentation (school open house, garden club, social studies or science fair, health fair, etc.)
- booklet (could be distributed by the local pharmacy or the library)
- posters
- Web page
- game

Reports might include these elements:

- written materials
- charts
- photographs
- drawings
- multimedia presentation (video, audio, computer presentation software)

CAUTION

Safety Note

All reports should warn readers that results are not meant for medical use. Reported or collected remedies may be harmful.

Activity 2

Exploring Herbs and Plants

Leader Notes

This activity lets learners explore more about the properties of various herbs and plants. Learners visit stations where they can sample herbal teas. They can also make an oatmeal facial scrub, taste garlic, and have other experiences.

We have included materials for eight stations. (Teas are grouped together to make using the material easier.) Select some or all of these stations. Create others of your own. This is a great chance to bring in materials from other cultures and places, or you can focus on locally grown herbs and plants. You may have learners from a variety of backgrounds in your group. If you do, select herbs that let all young persons share herbs that are part of their cultural experience.

Key Questions

- What are some of the properties of the herbs we learned about? In other words, how do they taste or smell? How would I recognize them?
- Where do the herbs grow?
- What may make the herbs useful as medicines?
- Why did our ancestors think these herbs might be medically useful?

Set Up Stations

Set up stations around the room for each type of exploration. You can use the tent cards (Handouts 2-12 through 2-22) to label stations. Try to have samples of the herb or plant as it exists in nature. If you can't get samples, use pictures. You may want to spread this activity out over two or more sessions. If so, don't try to set up every station every time. Select a smaller number of stations for each session. This will cut down

Materials Checklist

☐ Handouts 2-1 through 2-11 and 2-23 (1 per learner)

☐ Tent cards 2-12 through 2-22 (1 per station)

Tea Station

- ☐ small cups for hot water
- ☐ hot water
- ☐ spoons or wooden stirrers
- ☐ honey
- ☐ tea bags or loose teas (have enough for 2 of each type—chamomile, peppermint, ginseng, etc.—per learner) Note: Sassafras is available in liquid form in various concentrations. Check the label to see how much is needed.

Garlic Station

- ☐ roasted garlic (1 bulb per 7-10 learners) Note: To roast garlic, remove some, but not all, of the dried outer covering. Cut top and root base of the bulb. Sprinkle with vegetable or olive oil. Bake for one hour at 250°.
- ☐ raw, peeled garlic (1 bulb per 7-10 learners)
- ☐ crackers (1 per learner)
- ☐ plastic knives (1 per station)

Fennel Station

- ☐ fennel seeds (approximately 20 per learner)
- ☐ small plastic bags

Lavender Station

- ☐ small container with secure cap (1 per learner)
- ☐ unscented mineral oil or baby oil (1 ounce per learner)
- ☐ dried lavender (3-4 sprigs per learner)

the time you spend setting up stations and putting away materials.

We describe eight stations. (Teas are grouped together in one station for logistical reasons.) Select some or all of them, or create others. If you plan to do Activity 3 (Medicine Bags) after learners have visited all the stations, be sure to have extra materials, such as tea bags, to put into the medicine bags.

Tea Station. You will need plenty of hot water so learners can make small servings of each tea. Directions for making the tea are on the Exploration Notes and tent cards. You may wish to have learners prepare their own tea bags. Empty bags and loose herbs for teas can be found at many health food stores. In general, use one to two teaspoons of herbs per bag. Seal the bags with a hot iron or use a stapler. Learners will taste each tea and make notes for themselves so that they can describe the tea later. They can sweeten the teas with honey but may find it interesting to taste them before adding the sweetener.

On the tent cards provided, we used chamomile, peppermint, ginseng, and sassafras. Select from these teas or use others. Brief information about uses of each herb is included on the tent card.

Garlic Station. Garlic is a European bulbous herb of the lily family and is used in cooking. Roast enough garlic ahead of time to allow each learner to spread some on a cracker. You can roast the garlic cloves in aluminum foil. The foil can be a container to be used at the station. In addition to tasting roasted garlic on crackers, learners may wish to taste raw garlic. Tell learners about garlic's natural antibiotic properties. Encourage them to research other medicinal qualities of garlic. (It's often recommended as an aid to reducing blood pressure.) Some young people may enjoy reading legends about garlic.

Oatmeal Station

- ☐ uncooked oatmeal (approximately 2 tablespoons per learner)
- ☐ warm water (1-2 tablespoons per learner for mixing; extra for washing off oatmeal)
- ☐ small bowl for mixing
- ☐ a mirror
- ☐ rags for wiping face and hands
- ☐ old newspaper to cover floor and table

Salsa Station

- ☐ tortilla chips (approximately 5 per learner)
- ☐ small containers (1 per learner)
- ☐ spoons or stirrers
- ☐ salsa ingredients (see recipe below or use your own recipe) Note: You will need enough material for each person to have the following:
- ☐ 2 tablespoons chopped tomatoes
- ☐ 1 tablespoon chopped onions
- ☐ 1 teaspoon chopped bell peppers
- ☐ 1/8 teaspoon cumin
- ☐ 3 dashes of salt
- ☐ 1/8 teaspoon dried jalapeno pepper
- ☐ 1/8 teaspoon dried cayenne pepper

Aloe Station

- ☐ aloe plants (1 plant per 10 learners)
- ☐ lotion, cream, shampoo, and other products containing aloe for display

Ginger Station

- ☐ ginger snaps or other ginger cookies (1 per learner)
- ☐ ground ginger (small pinch or taste per learner)
- ☐ ginger root or crystallized ginger (a very thin slice for each learner)

Fennel Station. Fennel is often used as a breath freshener. Put this station after the garlic station. Fennel is a member of the carrot family. It is used around the world and bred for its leaves, aromatic seeds, and traditional healing properties. Have enough seeds so that each learner has several to chew. Fennel may be of special interest to budding poets. See the poetry of Longfellow or read the fennel reference section at the Orient Resources Company Web site at http://www.regencyworld.com/reffen.htm.

Lavender Station. This pretty plant is widely bred for its aromatic purple blossoms. Blossoms are often dried and used in *sachets*. The name lavender comes from the Latin *lavare*, which means to wash. Lavender is used in soaps and perfumes, and it also keeps away insects. In aromatherapy it is used as an antidepressant and antispasmodic. At this station, learners make their own scented bath oil. They can use mineral oil or unscented baby oil and dried lavender. To make a nice gift, fill a nicely shaped clear glass bottle with mineral oil and lavender sprigs. Use a cork stopper to close it tightly. Tying a ribbon around the neck of the bottle makes a nice display. Lavender is just one of many herbs and spices that are used in aromatherapy. Aromatherapy is another possible topic for research.

Oatmeal Station. Oats are a widely grown cereal grass. They are used to make meal. Oatmeal is soothing to the skin. Modern medicine still prescribes oatmeal baths for skin conditions. The Latin name of this plant, Avena sativa, gives a clue as to where you might find oatmeal in the drugstore (as Alveeno™, a bath product). Mix oatmeal and water, and apply it as a facial mask or scrub. Leave on for several minutes, then wipe off with soapy water and a rag.

Approximate Time Required

Herb stations, 2-3 hours

Environmental Notes

Leftover wet oatmeal can be spread in a thin layer and put out for birds or put into a compost pile. If kept sanitary, other leftovers can be consumed. Wash rags for reuse. Recycle paper.

Use rags instead of paper towels in activities that involve cleaning up. This saves money and is environmentally responsible. Rags reduce the amount of waste that goes into landfills. Old fabric can be easily reused or recycled.

What to Do in Advance

☐ Send letter home to determine if there are any relevant food allergies (see Leader Notes).

☐ Copy handouts and tent cards (Handouts 2-1 through 2-23) for all herbs used.

☐ Make Exploration Notes and tent cards for any additional herbs used.

☐ Prepare herb stations according to the directions that follow, or arrange for learners or others to do so. You may be able to get someone from a health food store, herbal store, grocery, or farmers' market to supply herbs.

< Definition

A **sachet** (pronounced *sa-shay*) is a small bag, usually containing dried herbs and sometimes perfume, used to scent clothes and linens.

Salsa Station. Making their own salsa can inspire learners' interest in the many medicinal uses of capsicum. Most young people have eaten salsa. But they may not know about capsicum, which is what makes peppers hot. Cayenne peppers have a long, twisted, pungent red fruit. It is dried and ground to make a hot spice. Capsicum, the compound from which cayenne gets its Latin name, has many other uses. It is used to help regulate blood pressure and improve digestion. It treats chronic pain.[28] When put on the skin, capsicum is used to reduce muscle aches and pain.

Capsicum does not dissolve in cold water. So, drinking ice water when you've had too much hot pepper doesn't stop the burning. Milk-based products help the burning. Many styles of cooking that feature spicy cooking, such as Indian and Thai, also offer yogurt-based dishes and milk-based drinks.

Provide small containers for learners to mix the ingredients. Don't skimp on the amounts of chopped vegetables for the salsa. They can then add cayenne and jalapenos to taste. Jalapeno (the *j* has an *h* sound) is a small, plump, dark green Mexican pepper. Warn learners about the heat in both peppers (they probably won't want to use more than 1/8 teaspoon of each). (See the complete list of ingredients in the Materials checklist above.)

Aloe Station. Aloe is sometimes called the miracle plant for burns. Learners may want to own one of these plants once they discover how useful it is. Aloe vera has long been used to heal external burns, wounds, and acne. It is also used internally by some to treat sores, ulcers, and digestive problems. You may want to grow some in your classroom, activity room, lab, or learning center. Have learners break off part of a leaf and squeeze some of the juice onto their skin. In their notes, they should describe how it feels. After they examine the products you display at the station, they can also list some of the products that have aloe as an ingredient.

CAUTION

Safety Notes

1. It is not easy to identify plants from drawings. Be safe. Use herbs from a grocery or reliable herb store. If you use locally gathered herbs, get help from a botanist. Make sure the plants are what you think they are. Make sure they are safe to use.
2. Allergies to food products are common. Some people have severe reactions to ordinary food. Make sure that none of the learners in your group has an allergy to the foods or herbs being used. You may wish to send a letter home to parents, listing the food items you will use. Ask them to contact you if any of the foods or herbs are of concern. You might also want to ask parents if they would like to donate any of the foods or herbs listed, or any herbs that represent their cultural traditions.
3. Hot water can be dangerous. Minimize the risk of burns by having an adult pour hot water for younger children or by using iced teas. Some studies indicate that safrole, a chemical component of sassafras, is carcinogenic. The liquid form of sassafras is safrole-free. To be safe, use the liquid form rather than making tea from roots.

Ginger Station. Those who get car sick will like this station. While some recent medical studies argue that prescription drugs treat car sickness better than ginger, other studies show the opposite. Ginger has fewer side effects and tastes better than prescription medicines. Ginger also treats nausea and indigestion. It soothes colds and sore throats. It is an antioxidant and antimicrobial. It helps to preserve foods. Young people will enjoy tasting gingerbread or ginger snaps. They might also taste a small piece of ginger, but they should be ginger about it! Freshly ground ginger root is a popular ingredient in Chinese cooking. Research sheds light on ginger as a folk remedy for a number of conditions.

CAUTION

Safety Notes

1. Hot peppers can be painful, particularly to the eyes! You may wish to have learners wear goggles and protective gloves when they are handling hot peppers. Learners should at least give their hands a good washing after touching any food. Encourage learners to taste a small amount of any pepper they wish to sample before chewing a larger piece. You may want to have milk or yogurt around. This will lessen the burning sensation learners may have if they eat too many hot peppers.
2. Latex gloves can produce severe allergic reactions in some people. If you use gloves, determine that none of the young people in your group has a latex allergy, or choose nonlatex gloves.

Prepare Learners for Station Visits

The Exploration Notes sheets can help learners think about what they can see and learn at the stations. Every sheet includes these questions about each plant or herb:

- What makes the plant's appearance distinctive (shape of leaf, color, fruit, kind of root)?
- What part of the plant is being used in this activity?
- How is that part being used? (Is it to be eaten? Applied to injury? Added to bath water?)
- What does the preparation (tea, mask, juice) taste or feel like?
- Where does the plant grow naturally?
- Speculate as to why that plant or its parts might be put to a particular use.

Invite Youth to Visit Each Station

Use the Exploration Notes provided as a guide to making additional Exploration Notes for herbs you add to the activity. Divide learners into groups that go from one station to the next to perform these tasks:

- observe the herb samples and/or drawings
- carry out the activity at the station
- record information about the herb and its uses on the Exploration Notes (Handouts 2-1 through 2-11)

You may want to have learners use their notes for additional activities. For example, they could use their notes to list three herbs thought to have natural antibiotic properties or two herbs whose bulbs or roots are used for healing purposes. After learners have visited all the stations, allow time for them to complete their notes before going to the next activity. The next activity is making medicine bags.

Species of many plants may vary with geographic regions. Local culture may influence which species of plant is used. We did not include scientific names of the plants on the tent cards in this project guide. Older learners can learn the professional terms used in botany and gardening by looking up the scientific names of plants. This can be a useful research activity. If you do not have time, or if the learners in your group are too young, simply introduce them to the scientific names. Scientific names for commonly used species of the plants mentioned in this activity are in Handout 2-23.

Activity 3

What Would Go into My Medicine Bag?

Leader Notes

This activity lets learners combine new information with what they already know about history, climate, and culture.

Key Questions

- How did traditional medical treatments differ in other places and times?
- If I had to carry a medicine bag today, what would I put in it?

Make the Medicine Bag

Medicine bags are made of plants and herbs selected from the stations on a return visit after learners have made the rounds described in Activity 2. Directions for making decorated medicine bags using paper bags, cutouts, colored pens, markers, and ribbons are in the Appendix (Handout 3-1). If time is limited, you may use a plastic grocery bag rather than a decorated bag.

Tell learners that people have always carried medical supplies with them on their travels. Throughout history, doctors were not always available, and most doctors today no longer make house calls. But the old-fashioned black doctor bag is still a symbol of Western medicine. In other cultures, a medicine bag on a string around the neck is a spiritual or cultural symbol. Today, many of us carry medicine in purses or backpacks.

Today, we see more high-tech ambulances than medicine bags. Still, the contents of a medical bag reflect the culture, climate, biology, and medical knowledge of a particular time and place.

Materials Checklist

☐ materials that were used for Activity 2
☐ paper lunch bags
☐ crayons
☐ glue
☐ hole punch
☐ marking pens
☐ ribbon
☐ copies of medicine bag directions (Handout 3-1)

Approximate Time Required

Medicine bags, 30 minutes

Medicine bags from various times and places, 30 minutes to 1 hour

Environmental Note

Recycle leftover paper.

What to Do in Advance

☐ Read Handout 3-1.
☐ Copy directions for bags (Handout 3-1).
☐ Gather paper bags and art materials.
☐ Get other reference materials you may need (atlas, encyclopedia, dictionary).

Use Medicine Bags to Explore Cultures

Have learners work in small teams to talk about what would go in bags in particular times, places, and cultures. They can then think about what materials would be appropriate for the bags. The following groups offer just a few possibilities. You and your group will be able to think of many others:

- an African American family in seventeenth-century North America
- a Puritan family in what is now the eastern United States
- Native Americans in eastern and western North America before the eighteenth century
- an Asian immigrant family in the seventeenth-century United States
- an Inuit family before the sixteenth century

Criteria for deciding what would be in the bag:

- *Availability.* For example, a plant that grows only in South America would have been unavailable to the twelfth century European. An item that requires refrigeration is unlikely to have been part of a medicine bag in a desert country before this century.
- *Usefulness.* A resident of Hawaii would probably not often need a treatment for frostbite.
- *Knowledge.* Learners can find out what people knew at a given time and place. For instance, none of the groups above had penicillin. However, they might have had plants or herbs with natural antibiotic properties.

Let learners have fun with this exercise. They can guess and brainstorm. Then, they can get back to reality by checking criteria. This is not meant to be formal research. It is a chance for learners to bring together knowledge from a variety of places and talk about what makes sense.

The Jigsaw Format

If you are doing this activity in a classroom or with a large group, you may want to use a jigsaw format. A jigsaw is a group activity. Members depend on one another for part of the information. Group members share their expertise.

Divide learners into smaller groups of four or five. These small groups are called expert groups. Each expert group makes a list of what they would put in the medicine bag in a particular place and time. Members write down the list made by their expert group. Then they make sure that they each can share with others why particular items were selected. They should also be able to say why other items did not make the cut.

Now form new groups. Each new group should have someone from each of the expert groups. Each member of the new group shares the list that his/her expert group made. They also share the reasons for those choices.

You may wish to have the groups make actual bags to decorate and share. If an item they wish to put into the bag is not available, they can put a picture of the item in the bag.

Activity 4

Color My World: Natural Dyes from Plants

Leader Notes

This activity engages learners in the use of plants to make natural dyes. This is both an art and a science and is traditionally linked with using herbs as medicine. Learners will carry out a simple chromatography activity. They will experiment with using plant materials as natural dyes. They will dye eggs or a cloth item (yarn, T-shirts, bandannas, and shawls are possible items learners may wish to dye).

Key Questions

- What are some nonmedical uses for local plants?
- How did our ancestors learn to use natural materials so well?
- How can our scientific skills let people know more about uses of local plants?
- How can we help conserve these plants?

Structuring This Activity

This activity includes three exercises: (1) Rainbow in a Marker, (2) Using Natural Dyes to Color Eggs, and (3) Experimenting with Natural Dyes on Fabric. Choose your exercises based on what you know of your group and how much time you have.

"Rainbow in a Marker" (see Handout 4-1 for instructions) is an introduction to the science of chromatography. It can be used to show how colors mix to form other colors. Use the exercise if you want to explore mixtures of colors. You can also connect it to the tools of current science. For younger children, mixing food colorings is an another way of exploring color.

If you do not have much time to work with natural dyes, choose egg dyeing instead of fabric dyeing. Egg dyeing is faster

Materials Checklist

Rainbow in a Marker activity

- ☐ Handout 4-1 (1 per learner)
- ☐ Small cup or glass (1 per learner or team)
- ☐ Strip of coffee filter paper (1 per learner or team, plus some extras) Note: Cut a strip about 1 inch wide and slightly longer than the water cup you are using. From large coffee filters, you can get 3 or 4 strips of paper.
- ☐ Various felt-tip markers, 1 of each color (Vis-a-Vis® green, blue, and black overhead transparency markers work well)
- ☐ Pencils to draw line across filter paper (1 per learner or team)
- ☐ Water (enough to fill a cup 1/2 inch deep)

Using Natural Dyes to Color Eggs

- ☐ Handout 4-2 (1 per learner)
- ☐ Eggs (1 per learner—more if learners will have the opportunity to experiment with various techniques; allow a few extras for breakage)
- ☐ Rags (to clean up dye spills and any breakage)
- ☐ Plant materials (generally allow about 4 cups of plant material per quart of water) Note: Suggested plant materials include red cabbage leaves, onion skins, cranberries, beets, spinach, raspberries, blackberries, blueberries, and various flower blossoms. Coffee, tea, paprika, and turmeric can be used in smaller amounts.
- ☐ Containers to boil plant material (1 per type of plant material used)
- ☐ Container to boil eggs (needed if you are using cold-dip process)
- ☐ Vinegar (approximately 2 tablespoons per quart)

and does not require mordants. However, fabric dyeing opens up more options. It teaches more of the historical, cultural, and economic uses of plants. It also opens the possibility for more follow-up activities such as science fair projects. Fabric dyeing can also produce a useful product.

Rainbow in a Marker

Use the activity in Handout 4-1 to introduce learners to the idea of a mixture of pigments containing different compounds.

Because some of the solvents typically used in separating pigments from leaves may be difficult to get or to get rid of, this activity uses water to separate colors in a marker.

Advanced learners may want to do a more complex chromatography activity. Directions can be found in science activity books or on the Internet.

Using Natural Dyes to Color Eggs

Handout 4-2 shows two basic ways to dye eggs. It also suggests more complex methods. If possible, have learners gather local plant materials to use in the activity.

Experimenting with Natural Dyes on Fabric

In this activity, learners experiment with dyeing wool yarn, cotton, or other natural fabrics with various types of plant products. This will truly be an experimental activity for your learners. Many things can happen when dyeing with natural materials. There will be much trial and error before they achieve the colors they want. You may know that a plant can make pigments of a color. But this does not tell you how to make that color. The same plant material may give a variety of colors. It depends on the mordant used and the way it is prepared.

Community resource note. You may wish to have a weaver or someone who naturally dyes textiles visit your group. They can talk about making textiles (combing, spinning, weaving, dyeing, etc.). This will provide a context for this activity. If there are textile factories in your area, try

- ☐ Strainer or colander
- ☐ Heat source (stove, hot plate)
- ☐ Plates or rags to keep work areas clean
- ☐ Small amounts of masking tape, wax or paraffin, rubber bands, onion skins, string, dental floss, or materials to be used in decorating eggs

Experimenting with Natural Dyes on Fabric

Note: Materials needed will vary. It depends on how much experimenting learners do, the numbers and types of plant products used, the type of fibers used, etc. The following list provides the general types of materials you will need. Quantities will depend on the plants and cloth items used.

- ☐ Smocks or aprons (or have learners wear old clothes on dyeing days)
- ☐ Handouts 4-3 to 4-7 (1 per learner)
- ☐ Cloth or yarn to dye (Material should be undyed and made of natural fibers. Old white sheets cut into sections can be used to make several shawls.)
- ☐ Natural fiber fabric or yarn scraps to dye in experiments
- ☐ Plant materials to use as dye sources
- ☐ Water for use in mordanting and dye baths
- ☐ Alum and cream of tartar to use in mordanting
- ☐ Containers for mordanting
- ☐ Containers for dye baths (should be stainless steel, iron, or nonreactive metal)
- ☐ Heat source (for producing dyes and for dye baths)
- ☐ Long-handled spoons, preferably wooden, to stir and to remove cloth from vats
- ☐ White vinegar
- ☐ Measuring spoons and utensils (cup, pint, quart, or metric measures) for use in preparing and refining recipes
- ☐ Dishwashing liquid
- ☐ Strainer (or old nylon hose) to strain plant materials from bath
- ☐ Newspapers to cover floor

to plan a field trip. Learners may not know the many steps involved in making clothing—from farm to shirt, etc.

Handout 4-3 shows general processes for mordanting fabrics in preparation for dyeing. You may or may not want to mordant fabrics when learners try dyeing for the first time. However, you should use a mordant when dyeing items that will be regularly worn and washed.

Handout 4-4 outlines procedures for dyeing. They also have some practical tips. Learners will need to develop a recipe for the kinds of plants and mordants they use. At first, they will need to experiment. Tell learners to keep careful records of their experiments. This way, others can follow their steps. With these records, your group can produce its own dye recipe book.

Handout 4-5 gives many examples of particular plants or plant parts used by others to do natural dyeing. Use the table to determine which materials are available locally to help you make the colors you want.

Learners can use Handout 4-6 to record their processes and results. Handout 4-7 has some general references on natural dyes and dyeing.

Approximate Time Required

Suggested introductory activities such as visit to or from a weaver who uses natural dyes, visit to a textile mill, visit to a cotton or sheep farm, 1-2 hours

Rainbow in a Marker: chromatography and mixing colors, 30 minutes

Collecting materials for egg-dyeing activity, 30 minutes to 1 hour—if cold dipping, you will need to spread the activity out over several hours or overnight

Dyeing eggs, 30 minutes to 1.5 hours

Chromatography and mixing colors to dye fabric, 30 minutes

Dyeing fabric, 6 hours, spread over at least 3 weekly meetings (Note: The amount of time needed for this activity depends on the amount of experimentation and research, the plant materials used, and whether or not learners make a recipe book.)

Environmental Notes

Recycle leftover paper.

When eggs begin to spoil, discard them in a compost pile or garbage.

Wash rags for reuse.

Evaporate solids from leftover alum or cream of tartar solutions, and reuse. When finished, any leftover solution can be washed down the drain.

What to Do in Advance

- ☐ Gather materials.
- ☐ Arrange for heat source for boiling eggs and plant materials.
- ☐ Make arrangements for any trips or visits from outside speakers.
- ☐ If you are dyeing fabric, collect fabric samples or have learners bring these.
- ☐ Make arrangements for group to collect plant materials.

You may choose to have learners dye a T-shirt, bandanna, *kente cloth*, shawl, or other clothing item that they can wear. Or you can use small pieces of wool and scrap materials. Materials to be dyed should be natural cotton or wool. Synthetics do not hold natural dyes well. If learners make an item that is likely to be washed, remind them that home-dyed fabrics will bleed the first few times they are washed. They may need to be washed separately in cold water.

Key Questions

- How does the type of material you are dyeing affect the color?
- How do different ways of preparing particular plants (chopping, crushing, leaving whole) influence dye color?
- What effect does the length of time in the dye bath have on color?
- Will different parts of plants produce different colors?
- How does changing the pH of the dye bath affect color?
- How can I produce a dye of a particular color using locally grown plants?
- What are other uses for particular dye plants?

< Definition

Kente cloth is a colorful African cloth woven on a narrow loom. It is woven into a narrow strip. The weave patterns in kente cloth have specific cultural meanings.

Environmental Note

Only gather plants that are abundant. Do not collect threatened or endangered species. Make sure that you have permission from the landowner before collecting any materials.

CAUTION

Safety Notes

1. Be very careful. Avoid contact with anything to which you might be allergic. Watch for the usual outdoor safety issues: snakes, sunburn, rough terrain, etc.
2. Hot materials can cause serious burns. Use age-appropriate methods for using hot materials. You may wish to have adults handle hot materials for young learners.
3. Some plant dyes are toxic. Eggs can spoil when not in the refrigerator. Do not eat the eggs used in this activity. Do not leave eggs where young children can get them.
4. In practice, many substances are used as mordants. Use only alum, cream of tartar, or acidic mordants in this activity. Other mordants are too toxic to use with young people. All mordanting should be done in a well-ventilated area. Learners should take care not to breathe fumes. Utensils you use for dyeing and mordanting should be dedicated for nonfood tasks. Do not reuse them for cooking!

Activity 5

Connections: Science and Traditional Knowledge

Leader Notes

This activity lets learners study the folk medicine topics that interest them most. Younger children often conduct research by getting information from books. But young people who are working on the other activities presented in this project are learning from many sources. They test the uses and properties of plants firsthand and investigate, categorize, and interpret data. They have opportunities to see the wisdom of people they know, such as neighbors and relatives. Some might begin to see cultural and biological diversity as a strength. The project teaches them that there is more to science than experimentation. The skills they use here are not only everyday thinking skills, they are science skills.

Key Questions

In this activity, learners ask and explore their own key questions. They build on ideas and questions from the first four activities. Help learners form questions about the remedies collected with the Traditional Knowledge Interview. Or help them form questions about the other activities in the guides. They may have had questions when they were organizing data. These may lead to good research questions. Their experiences with herbs and plants probably raised related questions or sparked interest in related topics. These can be used to further help them design their own research activities.

Researchers can work separately or in groups. It depends on the nature of the questions and what they prefer. Either way, the research they do should result in a creative report. A small group might decide to do some sort of media presentation or a Web page. An individual might want to do a poster display or a more traditional written

Materials Checklist

☐ Handouts 5-1 and 5-2 (optional)

☐ Any self-developed handouts on research and presentation guidelines

Approximate Time Required

Developing research question, 1 hour

Conducting research, 3-10 hours

Developing presentation, 3-6 hours

Making presentation, time varies

Environmental Note

Recycle leftover paper.

What to Do in Advance

☐ Develop guidelines for presentation or research.

☐ Arrange for access to library and/or computers.

☐ Copy Handouts 5-1 and 5-2, if they are to be used.

report. Still another might publish a newsletter or a tabloid news story. Encourage variety in presentations

How much experience have your learners had with self-directed research? If they don't have much, you may need to give them some structure. You can give them a time line for researching, writing and developing, revising, and presenting their reports. You may give them a form for keeping track of ideas. This form might include guiding questions like these: What cultures are you researching? What is the available medical research? How is the herb used? Where does the herb grow? What is the herb's role in history and in the economy? Work with the learners to help them assess the strength of various information sources. Be sure they understand that not all evidence is equally valid or useful.

Resources

The Resources section contains two lists that may be helpful. The first (5-1) lists books and other publications. The second (5-2) lists useful sites on the World Wide Web. You may wish to copy these lists for everyone doing this activity.

Connecting Back to the Community

There are many different ways learners can present their research. Help learners think of creative ways they can share their research with the community. They may want to do a performance. They can have a plant fair. They can celebrate the local ecosystem, do a spread in the local newspaper, or display photo essays and posters in the public library or supermarket. They may want to put together a booklet or make a presentation to local nature groups. They can become engaged in local plant conservation issues.

Materials Summary

Activities 1 through 5

Activity 1: Preserving the Wisdom of Our Elders

☐ Copies of the Traditional Knowledge Interview form (Handout 1-1) (1 for each interview to be conducted)

☐ Clipboard or notebook to serve as a writing surface

☐ Pens and pencils to record data

☐ Flip chart pad, posters, etc., to be used in data analysis phase

☐ Copies of "Functions of Various Herbs" (Handout 1-2) (optional—1 per learner or group)

Activity 2: Exploring Herbs and Plants

☐ Handouts 2-1 through 2-11 and 2-23 (1 per learner)

☐ Tent cards 2-12 through 2-22 (1 per station)

Tea Station

☐ small cups for hot water

☐ hot water

☐ spoons or wooden stirrers

☐ honey

☐ tea bags or loose teas (have enough for 2 of each type—chamomile, peppermint, ginseng, etc.—per learner)

Note: Sassafras is available in liquid form in various concentrations. Check the label to see how much is needed.

Garlic Station

☐ roasted garlic (1 bulb per 7-10 learners) Note: To roast garlic, remove some, but not all, of the dried outer covering. Cut top and root base of the bulb. Sprinkle with vegetable or olive oil. Bake for one hour at 250°

☐ raw, peeled garlic (1 bulb per 7-10 learners)

☐ crackers (1 per learner)

☐ plastic knives (1 per station)

Fennel Station

☐ fennel seeds (approximately 20 per learner)

☐ small plastic bags

Lavender Station

☐ small container with secure cap (1 per learner)

☐ unscented mineral oil or baby oil (1 ounce per learner)

☐ dried lavender (3-4 sprigs per learner)

Oatmeal Station

☐ uncooked oatmeal (approximately 2 tablespoons per learner)

☐ warm water (1-2 tablespoons per learner for mixing; extra for washing off oatmeal)

☐ small bowl for mixing

☐ a mirror

☐ rags for wiping face and hands

☐ old newspaper to cover floor and table

Salsa Station

☐ tortilla chips (approximately 5 per learner)

☐ small containers (1 per learner)

☐ spoons or stirrers

☐ salsa ingredients (see recipe below or use your own recipe) Note: You will need enough material for each person to have the following:

☐ 2 tablespoons chopped tomatoes

☐ 1 tablespoon chopped onions

☐ 1 teaspoon chopped bell peppers

☐ 1/8 teaspoon cumin

☐ 3 dashes of salt

☐ 1/8 teaspoon dried jalapeno pepper

☐ 1/8 teaspoon dried cayenne pepper

Aloe Station

☐ aloe plants (1 plant per 10 learners)

☐ lotion, cream, shampoo, and other products containing aloe for display

Ginger Station

☐ ginger snaps or other ginger cookies (1 per learner)

☐ ground ginger (small pinch or taste per learner)

☐ ginger root or crystallized ginger (a very thin slice for each learner)

Activity 3: What Would Go into My Medicine Bag?

- ☐ Materials that were used for Activity 2
- ☐ Paper lunch bags
- ☐ Crayons
- ☐ Glue
- ☐ Hole punch
- ☐ Marking pens
- ☐ Ribbon
- ☐ Copies of medicine bag directions (Handout 3-1)

Activity 4: Color My World: Natural Dyes from Plants

Rainbow in a Marker

- ☐ Handout 4-1 (1 per learner)
- ☐ Small cup or glass (1 per learner or team)
- ☐ Strip of coffee filter paper (1 per learner or team, plus some extras) (Note: Cut a strip about 1 inch wide and slightly longer than the water cup you are using. From large coffee filters, you can get 3 or 4 strips of paper.)
- ☐ Various felt-tip markers, 1 of each color (Vis-a-Vis® green, blue, and black overhead transparency markers work well)
- ☐ Pencils to draw line across filter paper (1 per learner or team)
- ☐ Water (enough to cover cup 1/2 inch deep)

Using Natural Dyes to Color Eggs

- ☐ Handout 4-2 (1 per learner)
- ☐ Eggs (1 per learner—more if learners will have the opportunity to experiment with various techniques; allow a few extras for breakage)
- ☐ Rags (to clean up dye spills and any breakage)
- ☐ Plant materials (generally allow about 4 cups of plant material per quart of water) (Note: Suggested plant materials include red cabbage leaves, onion skins, cranberries, beets, spinach, raspberries, blackberries, blueberries, and various flower blossoms. Coffee, tea, paprika, and turmeric can be used in smaller amounts.)
- ☐ Containers to boil plant material (1 per type of plant material used)
- ☐ Container to boil eggs (if you are using cold-dip process)
- ☐ Vinegar (approximately 2 tablespoons per quart)
- ☐ Strainer or colander
- ☐ Heat source (stove, hot plate)
- ☐ Plates or rags to keep work areas clean
- ☐ Small amounts of masking tape, wax or paraffin, rubber bands, onion skins, string, dental floss, or materials to be used in decorating eggs

Experimenting with Natural Dyes on Fabric

Note: Materials needed will vary. The following list provides the general types of materials you will need. Quantities will depend on the plants and cloth items used.

- ☐ Smocks or aprons (or have learners wear old clothes on dyeing days)
- ☐ Handouts 4-3 to 4-7 (1 per learner)
- ☐ Cloth or yarn to dye (Material should be undyed and made of natural fibers. Old white sheets cut into sections can be used to make several shawls or kente cloths.)
- ☐ Natural fiber fabric or yarn scraps to dye in experiments
- ☐ Plant materials to use as dye sources
- ☐ Water for use in mordanting and dye baths
- ☐ Alum and cream of tartar to use in mordanting
- ☐ Containers for mordanting
- ☐ Containers for dye baths (should be stainless steel, iron, or nonreactive metal)
- ☐ Heat source (for producing dyes and for dye baths)
- ☐ Long-handled spoons, preferably wooden, to stir and to remove cloth from vats
- ☐ White vinegar
- ☐ Measuring spoons and utensils (cup, pint, quart, or metric measures) for use in preparing and refining recipes
- ☐ Dishwashing liquid
- ☐ Strainer (or old nylon hose) to strain plant materials from bath
- ☐ Newspapers to cover floor

Activity 5: Connections: Science and Traditional Knowledge

- ☐ Handouts 5-1 and 5-2 (optional)
- ☐ Any self-developed handouts on research and presentation guidelines

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Eyes on Herbs

Handout 1-1

Traditional Knowledge Interview: Folk Remedies

Interviewer ____

Person Interviewed ____________________________________

Name ____

Date _____________ Age ______ M ____ F ____

Other Data ____

____

____

____

____

Directions for Interviewer

Complete a separate form for each interview. Be sure to write about where the person you are interviewing learned about the remedies he or she tells you about. Your leader may want you to include other information. Start your interview by saying something like this:

Hello, [Title and name of person you are interviewing—for example, Ms. Jones, Mr. Smith]. I am doing this interview as part of a project we are doing in [Girl Scouts, class, program, club]. We want to know about home remedies that people use for medical problems. We are doing this to honor the traditional knowledge people have about health so we can study how this knowledge may be related to other medical treatments.

I will name several medical conditions. Please tell me about old-time remedies that you have tried for these ailments or that you use regularly. Also please tell me about other remedies that you have heard about. We will put together all the information our group collects and use it for further research.

Before we begin, I would like some information about you. [Now fill in the information in the blanks above, and any that your leader has asked you to get.]

As you go through the questionnaire, try to get complete information. When you are finished, be sure to thank the person you interviewed for their time and help.

Remedies for:

Acne: ____________________

Allergies: ____________________

Asthma: ____________________

Baldness: ____________________

Bites/Stings: ____________________

Bleeding: ____________________

Bruises: ____________________

Burns: ____________________

Chapped Hands/Lips: ____________________

Colds: ____________________

Colic: ____________________

Coughs: ____________________

Corns: ____

Cuts: ____

Dandruff: ____

Earache: ____

Headache: ____

Heartburn: ____

Nosebleed: ____

Sleeplessness: ____

Snoring: ____

Sore Throat: ____

Sprains: ____

Sunburns: ____

Eyes on Herbs

Handout 1-2

Functions of Various Herbs

Term	Definition
Analgesic	Relieves pain
Antibacterial	Prevents the growth of bacteria
Antiseptic	Prevents the growth of germs
Astringent	Has a constricting or binding effect on tissues (such as closing pores)
Carminative	Expels gas, settles the digestive system
Demulcent	Smooths or reduces inflammation
Diaphoretic	Induces sweating
Digestive	Improves digestion
Diuretic	Removes water from the body, increases quantity of urine
Drying Agent	Absorbs moisture
Expectorant	Promotes coughing, stimulates saliva flow
Irritant	Designed to irritate
Nervine	Reduces anxiety and stress, calms and soothes the nervous system
Rubefacient	Stimulates circulation when applied to skin
Sedative	Has a quieting effect
Stimulants	Stimulates the nervous system
Styptic	Stops superficial bleeding

Definitions adapted from a variety of sources, including these:

Merriam Webster's Collegiate Dictionary 10th ed. 1993.

The Complete Family Guide to Natural Home Remedies by Karen Sullivan and E. Norman Sheay. Shaftesbury, Dorset; Rockport, MA: Element, 1997.

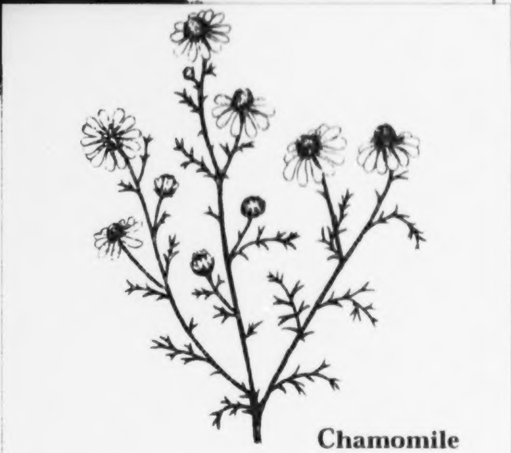
The Honest Herbal: A Sensible Guide to the Use of Herbs and Related Remedies by Varro E. Tyler. Port Jarvis, NY: Lubrecht and Cramer, 1993.

The American Medical Association Family Medical Guide by the American Medical Association. New York: Random House, 1987.

Exploration Notes

Handout 2-1

Chamomile



Chamomile

Chamomile: Strong scented foliage from the same family as daisies and marigolds. Flower heads contain bitter-tasting substance that is used as a soothing tonic.

Directions: Make a tea bag by putting 2 teaspoons of the herb in an empty tea bag and sealing the bag with heat or a stapler. You may also use a prepared bag if one is available. Put tea bag in a cup of hot water. Let it steep for 2-3 minutes, then taste. After tasting, you may wish to add honey and drink the tea.

1. What makes this plant's appearance distinctive (shape of leaf, color, kind of root, its fruit)?

2. What part of the plant is being used in this activity?

3. How is that part being used? (Is it to be eaten? Applied to injury? Added to bath water?)

4. What does the preparation taste or feel like? ____________________

5. Where does the plant grow naturally? ____________________

6. Speculate as to why this plant might be put to a particular use. ____________________

Completed by ____________________

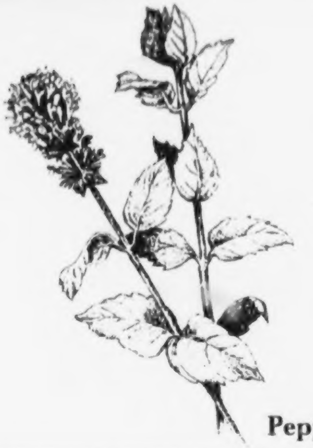
CAUTION: This plant should not be used as medical treatment except when supervised by a licensed medical practitioner.

BEST COPY AVAILABLE

Exploration Notes

Handout 2-2

Peppermint



Peppermint

Peppermint: A pungent and aromatic mint with dark green leaves, pink flowers. Has a cooling or antiseptic effect. It is used to aid digestion.

Directions: Make a tea bag by putting 2 teaspoons of the herb in an empty tea bag and sealing the bag with heat or a stapler. You may also use a prepared bag if one is available. Put tea bag in a cup of hot water. Let it steep for 2-3 minutes, then taste. After tasting, you may wish to add honey and drink the tea.

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6. Speculate as to why this plant might be put to a particular use. ______

Completed by ______

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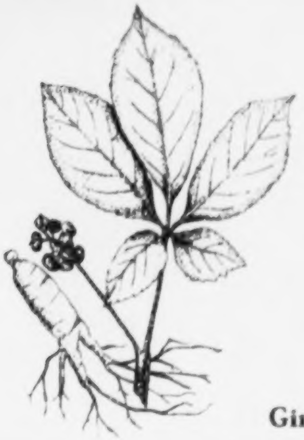
Exploration Notes

Handout 2-3

Ginseng



Ginseng

Ginseng: This ancient plant has scarlet berries and aromatic root. Dozens of health claims are made for the plant, which has been used in China since before recorded history.

Directions: Make a tea bag by putting 2 teaspoons of the herb in an empty tea bag and sealing the bag with heat or a stapler. You may also use a prepared bag if one is available. Put tea bag in a cup of hot water. Let it steep for 2-3 minutes, then taste. After tasting, you may wish to add honey and drink the tea.

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4. What does the preparation taste or feel like? __________

5. Where does the plant grow naturally? __________

6. Speculate as to why this plant might be put to a particular use. __________

Completed by __________

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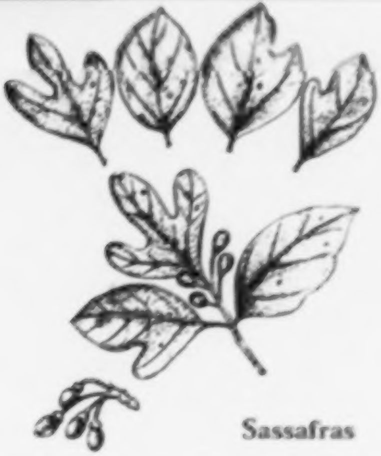
Exploration Notes

Handout 2-4

Sassafras



Sassafras

Sassafras: This tree with aromatic leaves has roots that can be dried, then boiled in water and used as a flavoring agent or tonic. Look up "diaphoretic" to see another use of sassafras.

Directions: Mix a small amount of the liquid tea mix with hot water. Stir and taste. After tasting, you may want to add honey and drink the tea.

1. What makes this plant's appearance distinctive (shape of leaf, color, kind of root, its fruit)?

2. What part of the plant is being used in this activity?

3. How is that part being used? (Is it to be eaten? Applied to injury? Added to bath water?)

4. What does the preparation taste or feel like?

5. Where does the plant grow naturally?

6. Speculate as to why this plant might be put to a particular use.

Completed by

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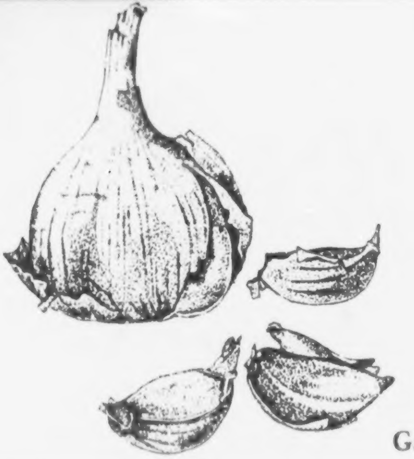
Exploration Notes

Handout 2-5

Garlic

Garlic: A European bulbous herb of the lily family. Widely cultivated for use in cooking, garlic has natural antibiotic and cholesterol lowering properties.

Directions: Spread a small amount of roasted garlic on a cracker and eat it. Take a small piece and chew it if you want to taste raw garlic.



Garlic

1. What makes this plant's appearance distinctive (shape of leaf, color, kind of root, its fruit)?

2. What part of the plant is being used in this activity?

3. How is that part being used? (Is it to be eaten? Applied to injury? Added to bath water?)

4. What does the preparation taste or feel like?

5. Where does the plant grow naturally?

6. Speculate as to why this plant might be put to a particular use.

Completed by

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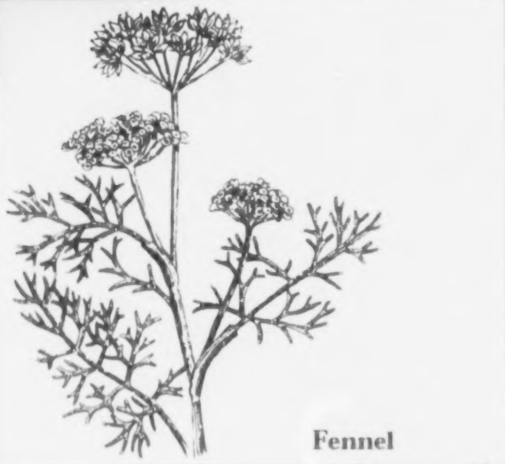
Exploration Notes

Handout 2-6

Fennel

Fennel: Member of carrot family cultivated for green, feathery foliage with tiny yellow flowers and aromatic seeds.

Directions: Chew several seeds as a breath freshener. Note the taste. Familiar?



Fennel

1. What makes this plant's appearance distinctive (shape of leaf, color, kind of root, its fruit)?

2. What part of the plant is being used in this activity?

3. How is that part being used? (Is it to be eaten? Applied to injury? Added to bath water?)

4. What does the preparation taste or feel like?

5. Where does the plant grow naturally?

6. Speculate as to why this plant might be put to a particular use.

Completed by

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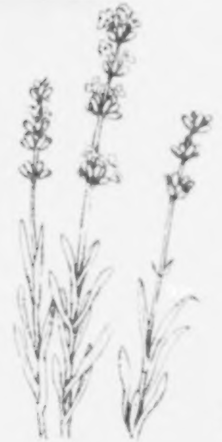
Exploration Notes

Handout 2-7

Lavender



Lavender

Lavender: Plant with purple blossoms and silvery leaves cultivated for aromatic blossoms. Often dried and used in sachets. Treatment for acne, among many other uses.

Directions: If you are making scented oil, put lavender sprigs in bottle. Fill with mineral oil. Cork tightly. Makes aromatic bath oil inexpensively. If you are making lavender tea, make a tea bag by putting 2 teaspoons of the herb in an empty tea bag and sealing the bag with heat or a stapler. You may also use a prepared bag if one is available. Put tea bag in a cup of hot water. Let it steep for 2-3 minutes, then taste. After tasting, you may wish to add honey and drink the tea.

1. What makes this plant's appearance distinctive (shape of leaf, color, kind of root, its fruit)?

2. What part of the plant is being used in this activity?

3. How is that part being used? (Is it to be eaten? Applied to injury? Added to bath water?)

4. What does the preparation taste or feel like? ______

5. Where does the plant grow naturally? ______

6. Speculate as to why this plant might be put to a particular use. ______

Completed by ______

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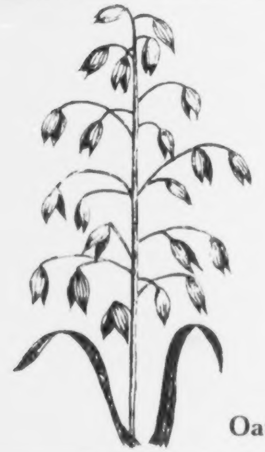
Exploration Notes

Handout 2-8

Oatmeal



Oats

Oat: A cereal grass ground to make meal. Used in baking and as breakfast food, but also exfoliates skin as a scrub or soothes skin as a bath.

Directions: Mix oatmeal and water in a thick solution. Apply as a facial mask or scrub.

1. What makes this plant's appearance distinctive (shape of leaf, color, kind of root, its fruit)?

2. What part of the plant is being used in this activity?

3. How is that part being used? (Is it to be eaten? Applied to injury? Added to bath water?)

4. What does the preparation taste or feel like?

5. Where does the plant grow naturally?

6. Speculate as to why this plant might be put to a particular use.

Completed by

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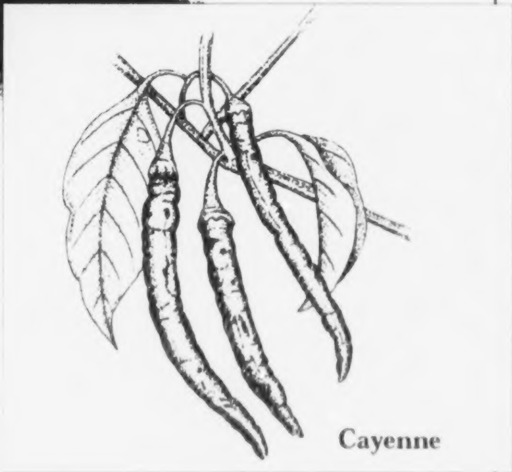
Exploration Notes

Handout 2-9

Cayenne



Cayenne

Capsicum (chile peppers): Dozens of varieties may be used for everything from gastric stimulation to clearing sinuses. Cayenne (pictured) is dried and ground to make a spice.

Directions: Make salsa according to the directions posted at the table or fill a cup with salsa and add cayenne pepper and jalapenos to taste. Use as dip for tortilla chips.

1. What makes this plant's appearance distinctive (shape of leaf, color, kind of root, its fruit)? ______

2. What part of the plant is being used in this activity? ______

3. How is that part being used? (Is it to be eaten? Applied to injury? Added to bath water?) ______

4. What does the preparation taste or feel like? ______

5. Where does the plant grow naturally? ______

6. Speculate as to why this plant might be put to a particular use. ______

Completed by ______

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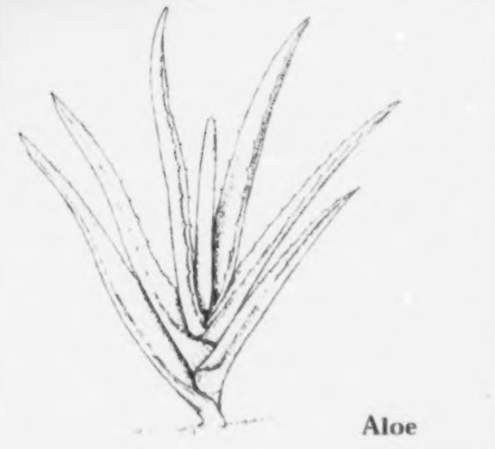
Exploration Notes

Handout 2-10

Aloe

Aloe: Succulent plant has long tapering leaves with toothed borders. Often found in kitchen pots as the "miracle plant" for burns. Ingredient in many lotions and creams.

Directions: Break off part of a leaf and squeeze juice onto skin. Rub it in and note how it feels.



Aloe

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2. What part of the plant is being used in this activity?

3. How is that part being used? (Is it to be eaten? Applied to injury? Added to bath water?)

4. What does the preparation taste or feel like?

5. Where does the plant grow naturally?

6. Speculate as to why this plant might be put to a particular use.

Completed by

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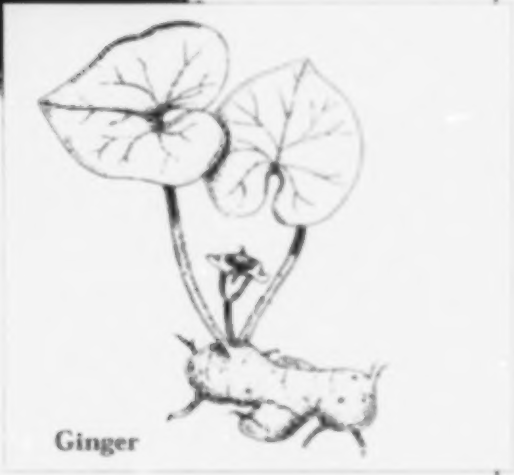
Exploration Notes

Handout 2-11

Ginger



Ginger

Ginger: A tropical root grown for its flavor as a dried and ground spice. Helps motion sickness with fewer side effects than some drugs used for that purpose.

Directions: Cautiously taste a small piece of ginger root. Then eat a cookie to see for yourself why the flavor is so popular.

1. What makes this plant's appearance distinctive (shape of leaf, color, kind of root, its fruit)?

2. What part of the plant is being used in this activity?

3. How is that part being used? (Is it to be eaten? Applied to injury? Added to bath water?)

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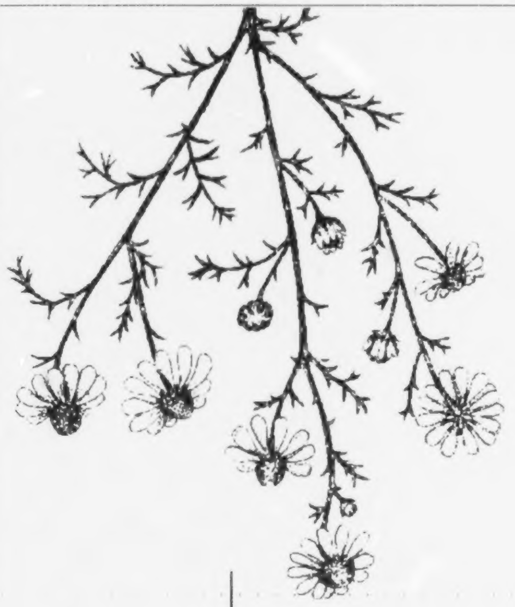

Tea Station
Chamomile

Chamomile: Strong scented foliage from the same family as daisies and marigolds. Flower heads contain bitter-tasting substance that is used as a soothing tonic.

Directions: Make a tea bag by putting 2 teaspoons of the herb in an empty tea bag and sealing the bag with heat or a stapler. You may also use a prepared bag if one is available. Put tea bag in a cup of hot water. Let it steep for 2-3 minutes, then taste. After tasting, you may wish to add honey and drink the tea.

Tea Station
Chamomile

Handout 2-12

Chamomile: Strong scented foliage from the same family as daisies and marigolds. Flower heads contain bitter-tasting substance that is used as a soothing tonic.

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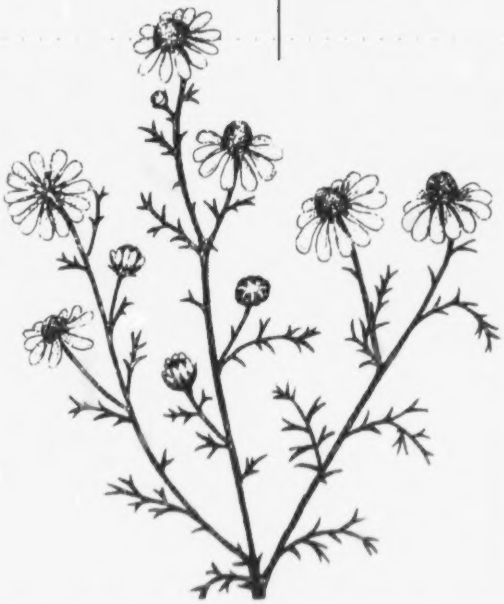

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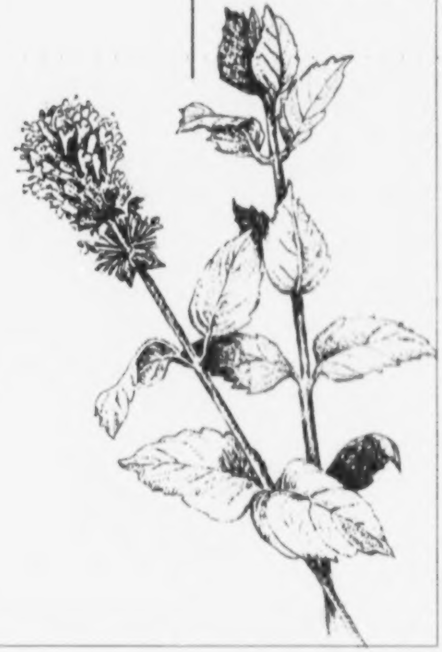
Tea Station

Peppermint

Handout 2-13

Peppermint: A pungent and aromatic mint with dark green leaves, pink flowers. Has a cooling or antiseptic effect. It is used to aid digestion.

Directions: Make a tea bag by putting 2 teaspoons of the herb in an empty tea bag and sealing the bag with heat or a stapler. You may also use a prepared bag if one is available. Put tea bag in a cup of hot water. Let it steep for 2-3 minutes, then taste. After tasting, you may wish to add honey and drink the tea.



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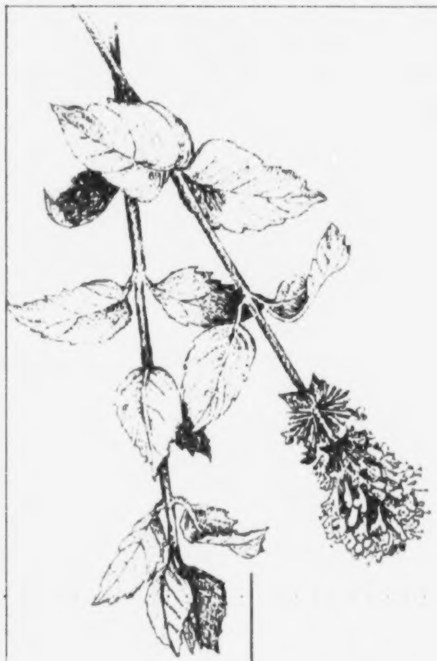

Tea Station
Ginseng

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Directions: Make a tea bag by putting 2 teaspoons of the herb in an empty tea bag and sealing the bag with heat or a stapler. You may also use a prepared bag if one is available. Put tea bag in a cup of hot water. Let it steep for 2-3 minutes, then taste. After tasting, you may wish to add honey and drink the tea.

Tea Station

Ginseng

Handout 2-14

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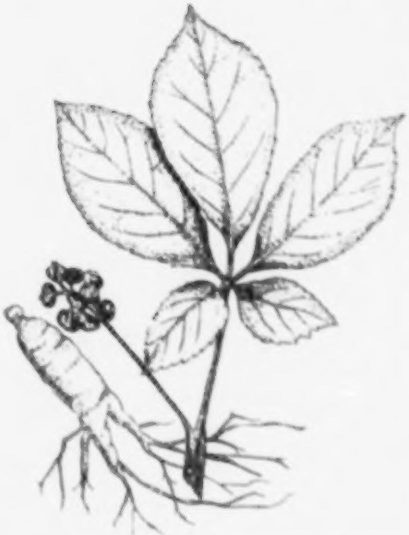
Directions: Make a tea bag by putting 2 teaspoons of the herb in an empty tea bag and sealing the bag with heat or a stapler. You may also use a prepared bag if one is available. Put tea bag in a cup of hot water. Let it steep for 2-3 minutes, then taste. After tasting, you may wish to add honey and drink the tea.



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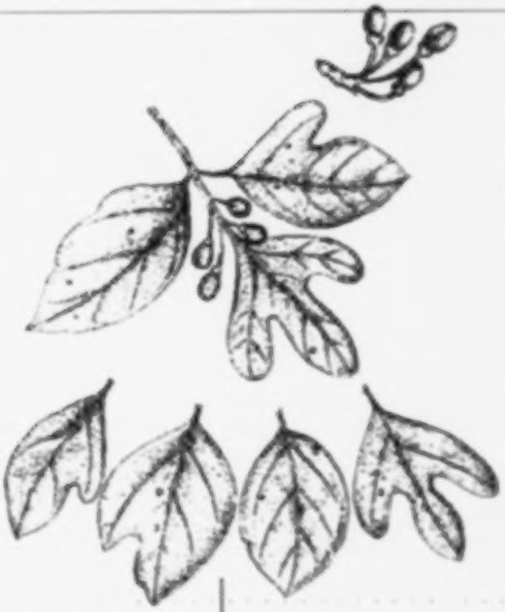

Tea Station

Sassafras

Sassafras: This tree with aromatic leaves has roots that can be dried, then boiled in water and used as a flavoring agent or tonic. Look up "diaphoretic" to see another use of sassafras.

Directions: Mix a small amount of the liquid tea mix with hot water. Stir and taste. After tasting, you may want to add honey and drink the tea.

Tea Station

Sassafras

Handout 2-15

Sassafras: This tree with aromatic leaves has roots that can be dried, then boiled in water and used as a flavoring agent or tonic. Look up "diaphoretic" to see another use of sassafras.

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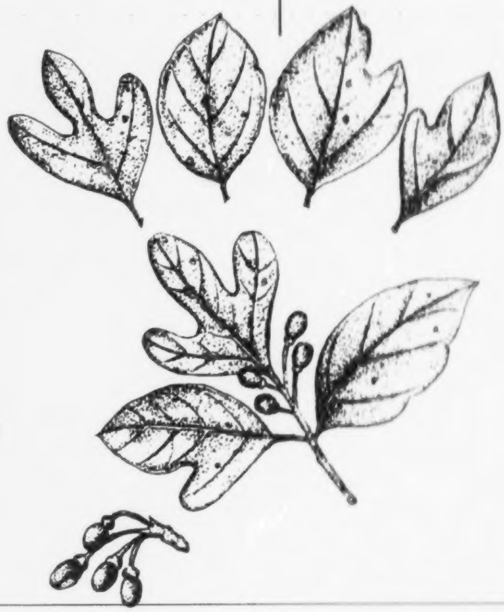

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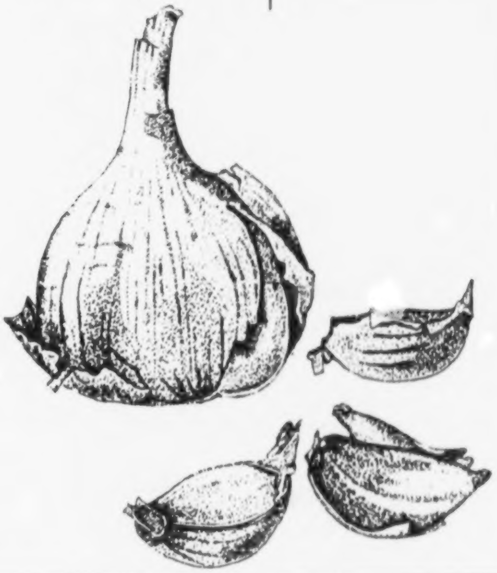
Garlic Station

Handout 2-16

Garlic: A European bulbous herb of the lily family. Widely cultivated for use in cooking, garlic has natural antibiotic and cholesterol lowering properties.

Directions: Spread a small amount of roasted garlic on a cracker and eat it. Take a small piece and chew it if you want to taste raw garlic.



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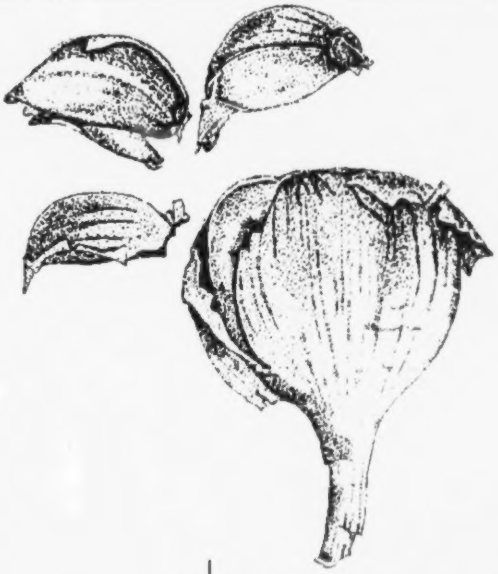

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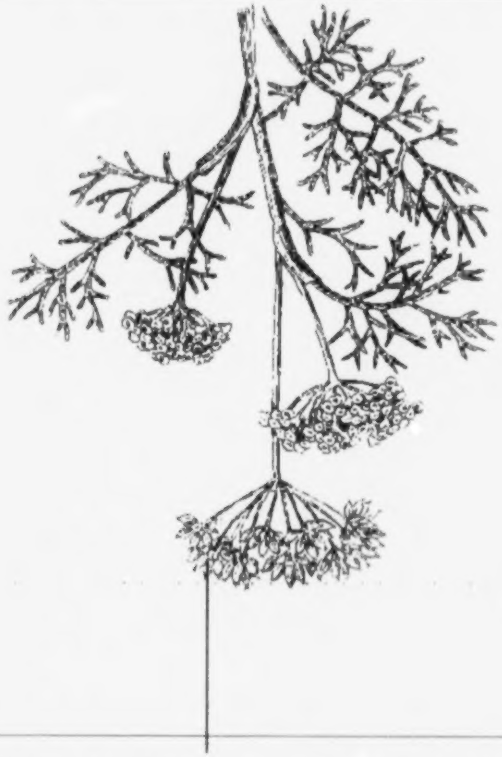

Fennel
Station

Fennel: Member of carrot family cultivated for green, feathery foliage with tiny yellow flowers and aromatic seeds.

Directions: Chew several seeds as a breath freshener. Note the taste. Familiar?

Fennel
Station

Handout 2-17

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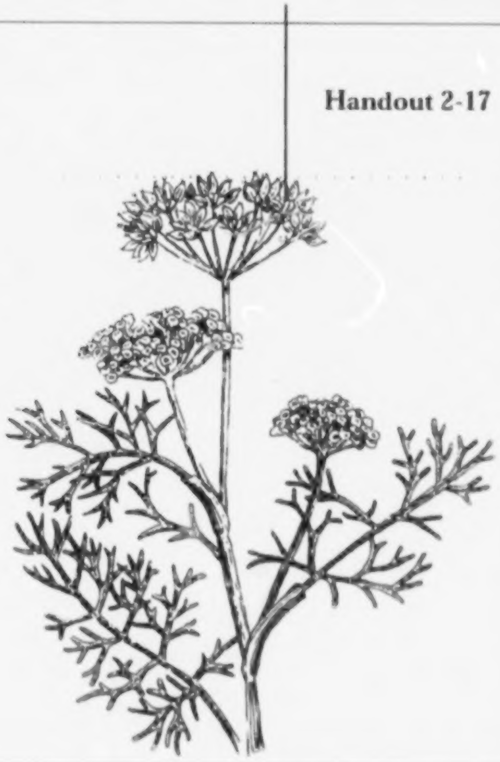
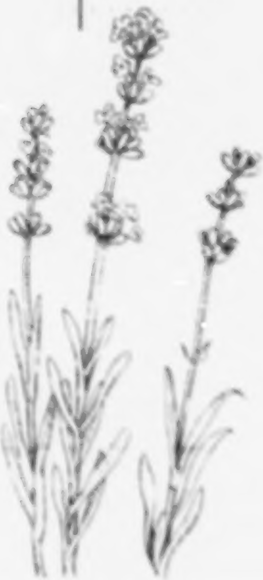
Directions: Chew several seeds as a breath freshener. Note the taste. Familiar?



Lavender
Station

Handout 2-18



Lavender: Plant with purple blossoms and silvery leaves cultivated for aromatic blossoms. Often dried and used in sachets. Treatment for acne, among many other uses.

Directions: If you are making scented oil, put lavender sprigs in bottle. Fill with mineral oil. Cork tightly. Makes aromatic bath oil inexpensively. If you are making lavender tea, make a tea bag by putting 2 teaspoons of the herb in an empty tea bag and sealing the bag with heat or a stapler. You may also use a prepared bag if one is available. Put tea bag in a cup of hot water. Let it steep for 2-3 minutes, then taste. After tasting, you may wish to add honey and drink the tea.

Lavender Station

Lavender: Plant with purple blossoms and silvery leaves cultivated for aromatic blossoms. Often dried and used in sachets. Treatment for acne, among many other uses.

Directions: If you are making scented oil, put lavender sprigs in bottle. Fill with mineral oil. Cork tightly. Makes aromatic bath oil inexpensively. If you are making lavender tea, make a tea bag by putting 2 teaspoons of the herb in an empty tea bag and sealing the bag with heat or a stapler. You may also use a prepared bag if one is available. Put tea bag in a cup of hot water. Let it steep for 2-3 minutes, then taste. After tasting, you may wish to add honey and drink the tea.

BEST COPY AVAILABLE

Oatmeal
Station

Handout 2-19

Oat: A cereal grass ground to make meal. Used in baking and as breakfast food, but also exfoliates skin as a scrub or soothes skin as a bath.

Directions: Mix oatmeal and water in a thick solution. Apply as a facial mask or scrub.

Oatmeal
Station

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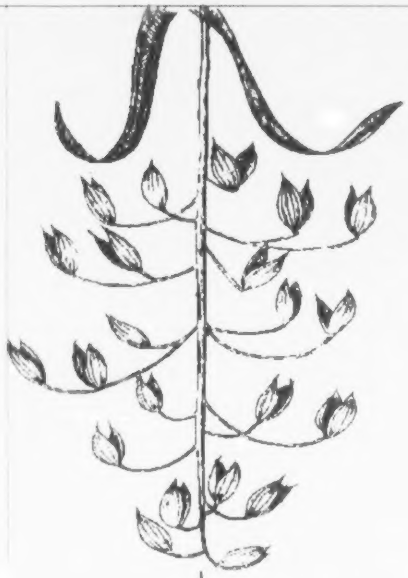
Directions: Mix oatmeal and water in a thick solution. Apply as a facial mask or scrub.



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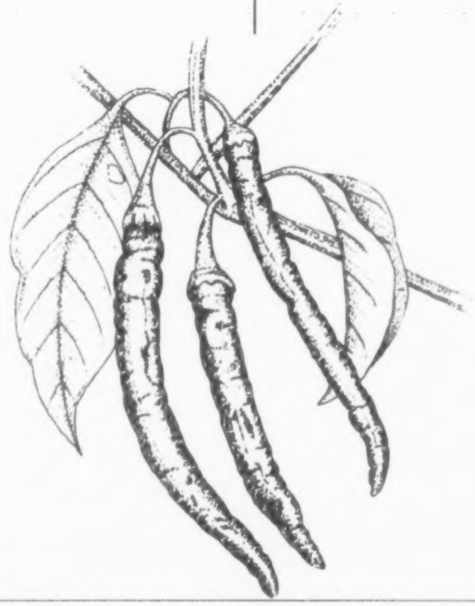
Cayenne
Station

Capsicum (chile peppers): Dozens of varieties may be used for everything from gastric stimulation to clearing sinuses. Cayenne (pictured) is dried and ground to make a spice.

Directions: Make salsa according to the directions posted at the table or fill a cup with salsa and add cayenne pepper and jalapenos to taste. Use as dip for tortilla chips.

Cayenne
Station

Handout 2-20



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Directions: Make salsa according to the directions posted at the table or fill a cup with salsa and add cayenne pepper and jalapenos to taste. Use as dip for tortilla chips.

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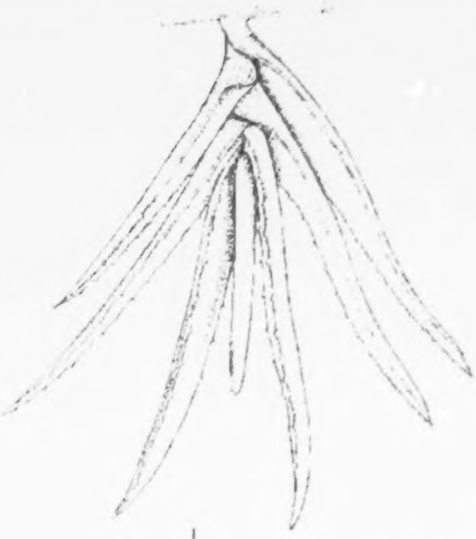
Aloe Station

Aloe: Succulent plant has long tapering leaves with toothed borders. Often found in kitchen pots as the "miracle plant" for burns. Ingredient in many lotions and creams.

Directions: Break off part of a leaf and squeeze juice onto skin. Rub it in and note how it feels.

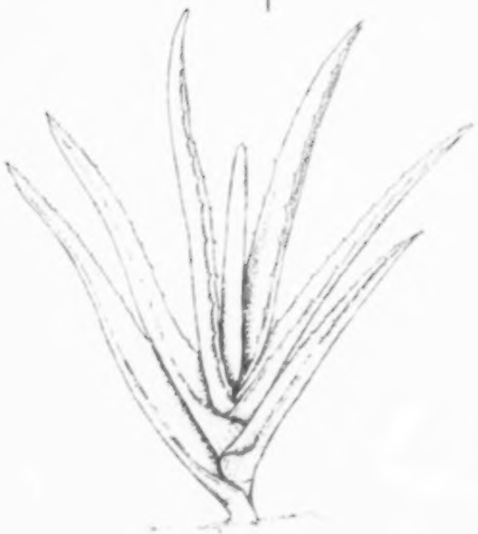


Aloe
Station

Handout 2-21

Aloe: Succulent plant has long tapering leaves with toothed borders. Often found in kitchen pots as the "miracle plant" for burns. Ingredient in many lotions and creams.

Directions: Break off part of a leaf and squeeze juice onto skin. Rub it in and note how it feels.

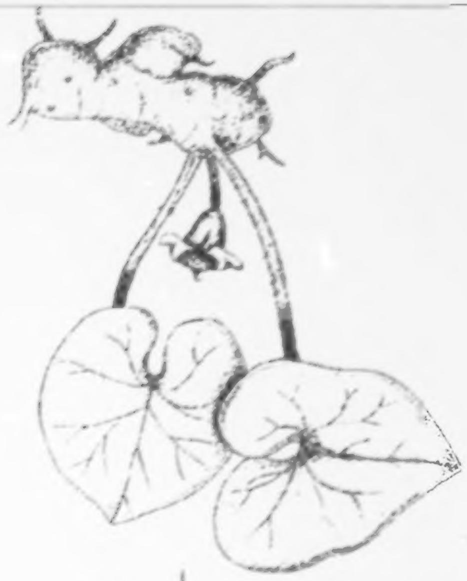


BEST COPY AVAILABLE

Ginger Station

Ginger: A tropical root grown for its flavor as a dried and ground spice. Helps motion sickness with fewer side effects than some drugs used for that purpose.

Directions: Cautiously taste a small piece of ginger root. Then eat a cookie to see for yourself why the flavor is so popular.

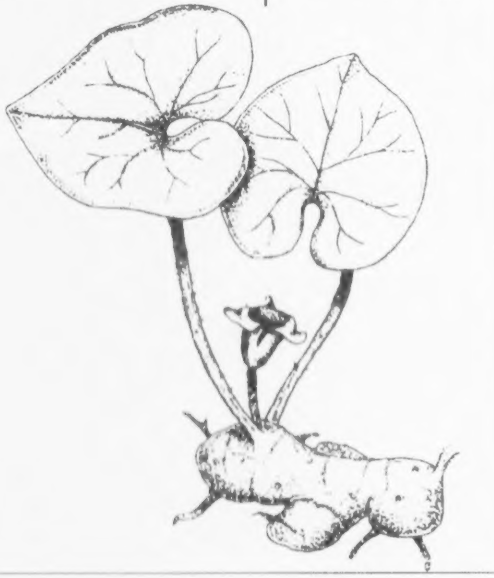


Ginger Station

Handout 2-22

Ginger: A tropical root grown for its flavor as a dried and ground spice. Helps motion sickness with fewer side effects than some drugs used for that purpose.

Directions: Cautiously taste a small piece of ginger root. Then eat a cookie to see for yourself why the flavor is so popular.



Eyes on Herbs

Handout 2-23

Scientific Names of Some Common Herbs

Herb or Plant—Common Name	Scientific Name(s)
aloe vera	aloe barbadensis
cayenne pepper	capsicum annum, capsicum minimum, capsicum frutescens (+ other capsicum species)
chamomile	anthemis nobilis, matricaria chamomilla
clove	eugenia caryphyllata
garlic	allium sativum, allium ursinium, allium vineale, allium oleraceum
fennel	foeniculum vulgare and foeniculum vulgare dulce are two best—known varieties
ginger	zingiber officinale
ginseng	panax ginseng (Asian ginseng), panax quinquefolius (American Ginseng)
lavender	lavandula stoechas (French or Spanish lavender), lavandula dentata (fringed lavender); lavandula officinalis (English lavender, true lavender); + other species
mullein	verbascum thapsus
oat	avena sativa
peppermint	mentha piperita
psyllium	plantago psyllium, plantago ovata
sassafras	sassafras albidum
spearmint	mentha viridis

Eyes on Herbs

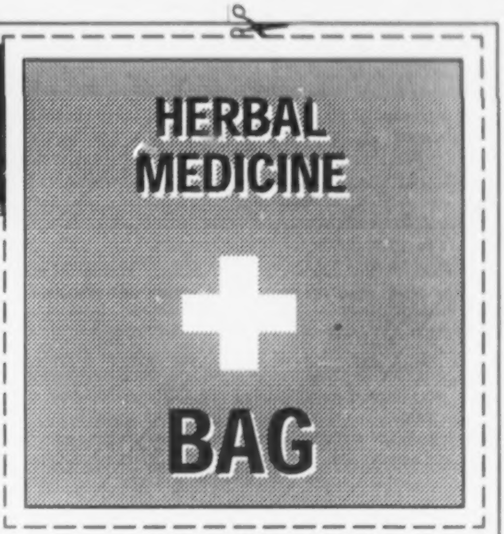
Handout 3-1

Medicine Bag Directions

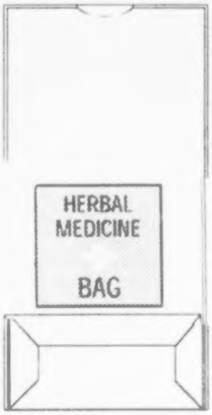
Materials needed:

- Bags
- Crayons
- Glue
- Hole Punch
- Marking Pens
- Ribbon

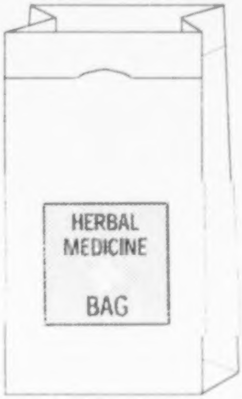
1. Decorate the bag with your own artwork. Design your bags in a way that is personally or culturally relevant. Use the seal provided only if you do not wish to draw your own design.


HERBAL
MEDICINE
BAG

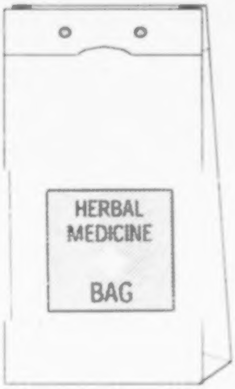
MEDICINE BAG HERBAL SEAL


HERBAL
MEDICINE
BAG

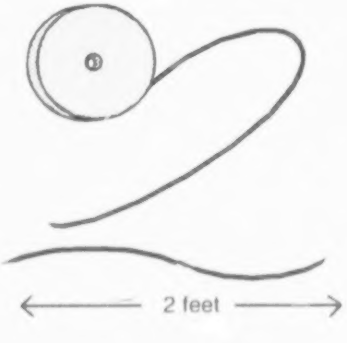
2. If you are using seal, glue to lower part of bag. If not—go to step 3.


HERBAL
MEDICINE
BAG

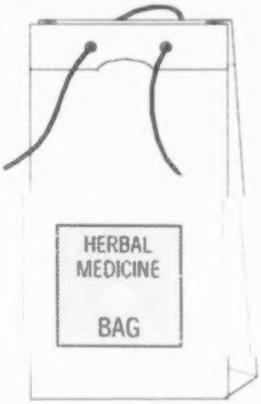
3. Open and fold down top of bag 2 inches.


HERBAL
MEDICINE
BAG

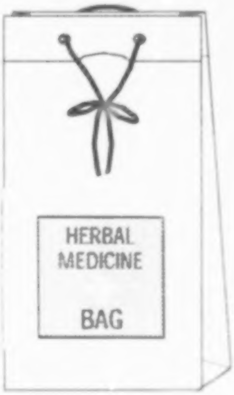
4. Punch 2 holes at top of bag in the folded area.



5. Cut 1 piece of ribbon 2 feet long.


HERBAL
MEDICINE
BAG

6. Lace the ribbon through the holes in the bag.


HERBAL
MEDICINE
BAG

7. Tie ribbon together at the ends.

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Eyes on Herbs

Handout 4-1

Rainbow in a Marker: Simple Separation of Colors in a Marking Pen through Paper Chromatography

Chromatography can be used to separate the parts of a mixture. This can help you find out how many different pigments are in leaves, for example. Chromatography can also be used to determine what compounds are in drugs and what chemicals are in natural products such as fruits or vegetables.

Scientists currently use chromatography in many different ways. You will be using chromatography today to separate the different pigments that were mixed to create the colors in felt-tip markers. The procedure you will use is very simple.

Directions: Fill a cup 1/2-inch deep with water. Using a pencil, draw a straight line across your filter paper, about 1 inch from the bottom. Using the different colors of markers provided, make small dots along the line, one for each color. (Make sure the dots are separated on the paper.)

Stand your filter paper in the cup, leaning the top of the paper against the side of the cup. Make sure that the water doesn't touch the ink on your dots! Allow the water to travel up the paper until it almost reaches the top of the paper.

What has happened to your original dots? What do you observe? Why do you think you see all the different colors? Did all the dots separate?

< Definition

Solvent is a substance that dissolves certain other substances. Water is a good solvent for many substances.

Capillary action refers to the attraction between the surface of a liquid and the surface of a solid. For example, when you put a paper towel in water, the water is attracted to the fibers in the towel. The water moves through the towel because of this attraction.

How does it work? Paper chromatography works because each compound that makes up a substance has a different chemical structure. This structure causes different compounds to dissolve at different rates. When a *solvent* (like water) is absorbed into paper through *capillary action*, it contacts the sample you are testing (the inks in a marker, for example). The first compound to be dissolved starts following the water's path. The next compound that is dissolved follows the water's path up the paper, but lags behind the first compound. Other components in the mixture may follow.

See if you can come up with some ways that paper chromatography might be used to test substances or provide information about a crime.

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Eyes on Herbs

Handout 4-2

Using Natural Dyes to Color Eggs: An Egg-citing Egg-stravaganza of Egg-cellent Science and Art!

The egg has been a symbol of spring and rebirth for thousands of years. Chinese, Greek, and Middle Eastern cultures, among others, included the egg in ceremonies or origin stories. Dyed eggs can make a beautiful decoration to celebrate festive occasions.

In this activity you will decorate eggs while experimenting with plants as sources of dyes. Your leader will tell you how many eggs you will be able to color and which materials are available for you to use.

CAUTION

Safety Notes

1. Some plant dyes are toxic.
2. Unrefrigerated eggs can spoil.
3. Don't eat the eggs from this activity or leave eggs where young children can eat them.
4. Hot water can be dangerous. Use care in handling hot water and objects (eggs or plants) that have been in hot water.

Method One: Cold Dipping

This method will produce soft, light shades. Use cold dipping to make eggs of one color or as a step in making designer eggs.

Boil eggs in water for at least 10 minutes. Boil plant materials in water separately, for at least 20 to 30 minutes. Let eggs and dye cool to room temperature. Strain the plant material from the dye mixture. Set eggs in the dye mixture for about 10 minutes, then remove and dry with clean rags.

Method Two: Hot Dipping

Hot dipping can produce darker colors. Put both eggs and plant materials together in the same pan of water. Add two tablespoons of vinegar for each quart of water. Boil for about 30 minutes.

Creating Designer Eggs

Different plant materials produce different colors. For example, red cabbage can produce a nice blue. Onion skins can produce yellow, orange, or reddish brown. Black walnut hulls can produce brown. Experiment with various kitchen substances, flowers, and wild plants to obtain the colors you want. Here are some tips for decorating eggs:

- Wrapping rubber bands, string, or dental floss around eggs before boiling can produce interesting striped designs.
- Rubbing designs on the eggs with wax or paraffin, or covering parts of the egg with masking tape before boiling, can create detailed designs.
- Hot-dip an egg in one color. After it cools, cold-dip half the egg in a second color. Combining double-dipping with other decorations can provide many interesting color effects.
- Before boiling, wrap eggs in onion skins or cabbage leaves. Tie the leaves on with string or rubber bands.

After you have finished your egg(s), display them. Share what you did to make your designs.

Eyes on Herbs

Handout 4-3

General Procedure for Mordanting

A mordant is a chemical that is used in dyeing to help the fabric retain color. All natural dyes fade over time. Mordants help reduce fading or bleeding of the color. In this activity, use alum and cream of tartar, which are nontoxic chemicals, as mordants.

Mordants can be used before, during, and after the dye process. The timing of the mordant may affect the results you obtain. For best results, mordant the fabric before dyeing.

Your leader will tell you what fabric you will be dyeing and will provide fabric scraps for experimenting.

Weigh the total amount of fabric you will be using.

Weight of dry fabric ______________

For each pound of dry fabric, measure out four ounces of alum. For example, if you have 3/4 pound of dry material, you will need 3 ounces of alum. If you have 1-1/2 pounds of material, you will need 6 ounces of alum.

Amount of alum needed ______________

Use 1 ounce of cream of tartar for every pound of dry fabric.

Amount of cream of tartar needed_________

Dissolve the alum and the cream of tartar together in 4 gallons of cold water. The water should be in a container that you can use for heating the solution and fabric. This solution is called a mordant bath.

Wet the fabric thoroughly, squeeze out excess water, then soak the fabric in the mordant solution. Do not twist or wring the fabric—you can create streaks and blemishes in the color.

CAUTION

Safety Note

Many mordants are toxic. Even though you may see other mordants referenced in your research, do not experiment with toxic mordants.

Slowly heat the mordant bath to boiling and boil gently for one hour. From time to time, use a long wooden spoon to turn the material in the bath. You may need to turn the heat down and/or add additional water after the bath comes to a boil. Stir occasionally. After an hour of boiling, allow the bath to cool slowly.

If you plan to dye the fabric the same day, allow the bath to cool to room temperature.

Environmental Note

Many mordants, particularly those made of metallic salts, are environmentally harmful. Many weavers began using natural dyes and nontoxic mordants as a way of lessening their long-term impact on the environment.

Rinse the mordanted fabric thoroughly in warm water. Keep the fabric wet until time for dyeing by soaking it in a pan of clean water.

If you plan to dye the fabric at a later date, leave the fabric soaking in the bath overnight. The next morning, gently squeeze excess moisture out of the fabric. Don't twist or wring out the fabric! Hang the fabric up to dry.

Rinse the fabric well before you dye it.

CAUTION

Safety Note

Boiling water can cause severe burns. Be extremely cautious while boiling and stirring mordant and dye baths.

Eyes on Herbs

Handout 4-4

Preparing the Dye Materials and Bath

Gather or select the plant materials you will be using. You will need an amount of the plant material that weighs approximately ten times the weight of the fabric you will be dyeing.

Weight of plant material needed___________

Rinse off dirt and insect matter. Finely chop any leaves, roots, skins, flowers, or stems you are using. If you are using berries, crush them. Crush any roots, bark, or nuts you are using. If you are using walnuts, use the outer shell covering the nut, as well as the nut itself.

Keep careful records of the procedures you use. You will use your notes later to write a recipe for dyeing with your plant material. Handout 4-7 is a form for keeping track of your procedures. Use a copy of Handout 4-7 for every experiment you attempt.

After plant materials are cleaned, chopped, or crushed, put them in a large container. Pour water over them. Let the materials soak overnight.

The next day, slowly bring plant materials and water to a boil. Boil materials from 30 minutes to 2 hours to obtain a deep shade of pigment. Simmer leaves, flowers, berries, and fruits for about 30 minutes. Roots and barks need to boil for about an hour. Boil nuts vigorously for two hours.

After the dye bath has boiled long enough, you may want to strain the plant materials out of the bath. Or you can leave the plants in the bath. You may want to experiment with both procedures. If you strain the liquid, be very careful in handling hot liquid and plants! Your leader may wish to carry out this procedure for you.

Put your fabric into the dye bath or the strained liquid. Gradually heat the dye bath to a boil and simmer until you get the color you want. Simmering times may range from 15 minutes to several hours.

When the desired shade is reached, turn off the heat under the dye bath. Allow the fabric to cool in the bath, then wash it gently with warm, soapy water. Rinse the fabric in cool or cold water.

General Procedure for Dyeing

After you have prepared the fabric you plan to dye, wash it in warm tap water. Add a small amount of detergent. Mix well. Make sure the fabric is completely wet. Let the fabric stand in water for 30 minutes. Rinse the fabric well in clean, warm water.

Important Tips

- Use a dye bath container large enough to allow the dye bath to completely cover the fabric.
- Make sure the fabric is completely soaked in the dye bath.
- Heat and cool dye baths slowly.
- Rinse fabrics with water the same temperature as the previous dye bath or leave the fabric in the dye bath until it is cool.
- Rinse thoroughly after dyeing. Otherwise, the dye may rub off later.
- Stir the fabric regularly to make sure that the color is even.
- Wet fabric generally looks darker than it will look once it dries.
- The longer you leave the fabric in the dye bath, the deeper the color will get.
- To make darker colors, you may need to dye the fabric two or three times. You may also want to try leaving the fabric to cool in the dye bath overnight.
- Do not use the fabric until it is completely dry.
- Do not hang the dyed fabric in direct sunlight.

Eyes on Herbs

Handout 4-5

Some Dye Sources and Colors

Color	Source
red	madder roots, pokeberries, sassafras bark, red cedar bark, red onion skins, currants, sumac leaves*, wild plums, tamarack bark, dock roots, red dogwood bark, chokecherry bark, various lichens and mosses, sorrel roots, dandelion roots
pink	raspberries (mixed with lemon juice), heather flowers and shoots, wild madder roots, mulberries, red cabbage, beet leaves and roots
orange	onion skins, goldenrod flowers, dandelion flowers, carrot tops, aster flowers, henna leaves, coreopsis petals
yellow/gold	turmeric powder, turmeric root, dandelion blossoms, sunflower petals, lichen, pomegranate peel, marigold flowers, zinnia flowers, parsley leaves, mint leaves, chamomile flowers, mullein flowers, Queen Anne's lace flowers, Osage orange bark and wood, ragwort leaves and flowers, white grapes, black oak bark, dogwood bark, moss, apple or pear bark, jewelweed flowers, sumac bark*
green	spinach leaves, evergreen leaves or needles, oak leaves, dandelion stems, goldenrod flowers mixed with indigo leaves and stems, lichens, bracken leaves, foxglove leaves, dark green nettles, ragweed flowers and leaves, carrot tops
blue	red cabbage, indigo leaves and stems, black raspberries, larkspur flowers, yellow iris roots, blueberries with beech bark, privet berries and leaves
purple/indigo	woad leaves and stems, indigo leaves and stems, blueberries, blackberries, wild grapes, poke root, mulberries, elderberries, white maple bark or rotted wood, logwood (heartwood), dandelion roots, nightshade berries, purple loosestrife plants and flowers, St. John's wort flowers

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Some varieties of sumac are poisonous, having an effect similar to poison ivy. If you cannot confidently identify the variety of sumac you collect, do not collect sumac.

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brown	hickory nuts or walnuts gathered green then allowed to turn black, ground hazelnuts, pinecones, pine tar, buckeyes, goldenrod plants, rushes, sage leaves, briar roots, onion skins, teas, coffee grounds
black	black walnut husks, wild grapes, maple bark, burr oak bark, the heartwood of a tree, alder bark, various lichens

Environmental Note

Humans have had a major impact on woodland environments. Loss of habitat, overharvesting, grazing, invasive plants, clear-cutting, and pollution have endangered or threatened many native plants.

To minimize your impact on the environment

- Make sure any plants you collect are common. Do not collect rare, endangered, or threatened species. Do not collect plants that are covered by regulations—they are protected for a reason! A number of plants traditionally used in dyeing, such as bloodroot and butternut, are now rare and should not be collected.
- Be careful not to disturb the environment or other species. "Take a mess, don't make a mess."
- Take only what you need for your own use. (However, if you are collecting *invasive* or *exotic* plants such as woad or purple loosestrife, it may be environmentally beneficial to take as much of the plant as possible. Just don't disturb other species in the process.)
- When collecting bark from trees or roots from perennial plants, gather materials in such a way as to minimize harm to the plant. For example, collect bark in small strips running vertically along branches or the trunk of the tree. Leave other strips in place to carry sap. Removing the bark from all around a tree can stop sap flow and kill the tree. Take only small portions of roots to leave plants and trees healthy and capable of continued growth and reproduction.
- When possible, restore what you have taken by planting the seeds or nuts so that new plants can sprout and grow.
- If you decide to use a dye on a larger scale—for example, to dye materials for your group to sell—collecting may have a significant environmental impact. Develop methods other than collecting from natural areas for getting plant materials for large-scale use.

This information was obtained by experimentation and from other sources, including these:

Natural Dyes and Home Dyeing by Rita Adrosko. New York: Dover Publications, 1971.

A Dyer's Garden by Rita Buchanan. Loveland, CO: Interweave Press, 1995.

The Database of Dyes (Bicnet Infoservices Private Limited, www.bicserve.com/htm/dyes/index.htm), 1999.

Nature's Colors: Dyes from Plants by Ida Grae. New York: Macmillan, 1974.

Earth Tones, Colors from Western Dye Plants by Carol Todd. Creston, CA: Rowland Press, 1995.

The Art and Craft of Natural Dyeing: Traditional Recipes for Modern Use by J. N. Liles. Knoxville: University of Tennessee Press, 1990.

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Eyes on Herbs

Handout 4-6

Experimental Procedure

Name(s): ____________________

Type of fabric used (cotton, wool, linen, etc.):

____

Plant species used: ____________________

Part(s) of plant used (leaf, stem, bark, nuts, roots, flowers, hulls, berries, fruits, tubers, skins, etc.):

____

Weight of plant material used: ____________________

Date plant material was gathered: ____________________

How were plant parts prepared (crushed, torn and soaked in water overnight, ground and boiled, etc.)? ____________________

____

____

Was a mordant used? If so, what type? How was it used? ____________________

____

Was plant material boiled before using in dye bath? If so, how long? ____________________

Was liquid strained before putting into dye bath? ____________________

How much water was used in the dye bath?

____

How long was fabric simmered in dye bath?

____

How long did fabric soak in dye bath after simmering?

____

How was fabric cooled, rinsed, and dried after dye bath? ____________________

____

____

____

____

Color obtained: ____________________

Other procedures or notes: ____________________

____

____

____

____

____

____

____

____

Results: ____________________

____

____

____

____

____

____

____

Attach a small piece of dyed fabric below to show the exact shade obtained.

Staple or glue your fabric sample here.

Handout 4-7

Selected Books on Natural Dyes

A Dyer's Garden by Rita Buchanan. Loveland, CO: Interweave Press, 1987.

A Weaver's Garden by Rita Buchanan. Loveland, CO: Interweave Press, 1995.

Earth Tones, Colors from Western Dye Plants by Carol Todd. Creston, CA: Rowland Press, 1995.

Natural Dyes and Home Dyeing by Rita Adrosko. New York: Dover Publications, 1971.

Nature's Colors: Dyes from Plants by Ida Grae. New York, NY: Macmillan, 1974.

Rodale's Illustrated Encyclopedia of Herbs by Claire Kowalchik and William Hylton (eds.). Emmaus, PA: Rodale Press, 1988.

The Art and Craft of Natural Dyeing: Traditional Recipes for Modern Use by J. N. Liles. Knoxville: University of Tennessee Press, 1990.

The Plictho of Rosetti Gioanventura by Rosetti Gioanventura, translated by Sidney Edelstein and Hector Borghetty. Cambridge, MA: Massachusetts Institute of Technology Press, 1969, translation of 1548 work.

Eyes on Herbs

Handout 5-1

Selected Books on Medicinal Herbs

American Herbal Products Association's Botanical Safety Handbook edited by Michael McGuffin. Boca Raton, FL: CRC Press, 1997.

Blended Beauty: Botanical Secrets for Body & Soul by Philip B. with Lucy Fraser and Wendy Ryerson. Berkeley, CA: Ten Speed Press, 1995.

Family Guide to Natural Medicine: How to Stay Healthy the Natural Way. Plesantville, NY: Reader's Digest Association, 1993.

Herbs for Your Health: A Handy Guide for Knowing and Using 50 Common Herbs by Steven Foster. Loveland, CO: Interweave Press, 1996.

Honey, Mud, Maggots, and Other Medical Marvels: The Science Behind Folk Remedies and Old Wives' Tales by Robert Root-Bernstein and Michele Root-Bernstein. Boston: Houghton Mifflin, 1997.

The Alternative Medicine Sourcebook: A Realistic Evaluation of Alternative Healing Methods by Steven Bratman. Los Angeles: Lowell House, 1997.

The Complete Book of Herbs & Spices by Sarah Garland. Pleasantville, NY: Reader's Digest Association, 1993.

The Complete Family Guide to Natural Home Remedies by Karen Sullivan and E. Norman Sheay (eds.). Shaftesbury, Dorset; Rockport, MA: Element, 1997.

The Green Pharmacy: New Discoveries in Herbal Remedies for Common Diseases and Conditions from the World's Foremost Authority on Healing Herbs by James A. Duke. Emmanus, PA: Rodale Press, 1997.

The Healing Kitchen: An Indoor Herb-Garden Pharmacy for Cooks by Patricia Stapley. Indianapolis, IN: Macmillan USA, 1996.

The Honest Herbal: A Sensible Guide to the Use of Herbs and Related Remedies by Varro E. Tyler. Port Jarvis, NY: Pharmaceutical Products Press, 1993.

The Medical Advisor: The Complete Guide To Alternative & Conventional Treatments by the editors of Time-Life Books. Alexandria, VA: Time-Life Books, 1997.

The People's Pharmacy by Joe Graedon and Teresa Graedon. New York: St. Martin's Press, 1996.

Eyes on Herbs

Handout 5-2

Web Sites for Beginning Herb Research

HerbWeb: Ethnobotany
http://www.herbweb.com/herbweb/ethno.htm

Botanical.com (Scientific Information on Herbs)
http://www.botanical.com/

Medical Herbalism Ethnobotany
http://medherb.com/ETHNOBOT.HTM

Internet Directory for Botany: Economic Botany, Ethnobotany
http://herb.biol.uregina.ca/liu/bio/subject/botecon.html

The Peoples Pharmacy
http://homearts.com/depts/health/kfpeopf1.htm

MedWeb Plus database links for searching on medical topics
http://medwebplus.com/subject/

History of Medicine and Health
http://ihs2.unn.ac.uk:8080/hhist.htm

Mildred E. Matthews Botanical Garden Botany textbooks
http://www.lifesci.ucla.edu/botgard/html/bg-btx.html

Ethnomedicinals (Medicinal Biologicals) Herbs, Magic, and Science
http://walden.mo.net/~tonytork/text.html

Cyberbotanica: Plant Compounds and Chemotherapy
http://biotech.chem.indiana.edu/botany/

Canoe Plants: Introduction & Contents
http://www.hawaii-nation.org/canoe/

Algy's Herb Page—Apothecary
http://www.algy.com/herb/medcat.html

Agricultural Research Service Phytochemical and Ethnobotanical Databases
http://www.ars-grin.gov/duke/

Health Care Information Resources: Alternative Medicine (links to information on scores of alternative medical practices)
http://www-hsl.mcmaster.ca/tomflem/altmed.html

Botany. Vatican Exhibit
http://www.ncsa.uiuc.edu/SDG/Experimental/vatican.exhibit/exhibit/g-nature/Botany.html

NativeTech: Indigenous Plants and Native Uses in the Northeast
http://www.nativetech.org/plantgath/plantgaht.htm

Native American Herbal. Plant Knowledge and Identification
http://indy4.fdl.cc.mn.us/~isk/food/plants.html

USDA Natural Resources Conservation Services Plants Database
http://plants.usda.gov/plantproj/plants/

Alternative Medicine Homepage
http://www.pitt.edu/%7Ecbw/altm.html

National Center for the Preservation of Medicinal Herbs
http://www.ncpmh.org/

Holistic Internet Resources: Homepage
http://www.hir.com/

Homepagers' Herbal Remedies
http://www.cam.org/%7Efishon1/folk.html

A Modern Herbal by Mrs. M. Grieve (a 1931 text on herbs and folklore)
http://www.botanical.com/botanical/mgmh/mgmh.html

WWW Virtual Library History of Science, Technology & Medicine
http://www.asap.unimelb.edu.au/hstm/hstm_ove.htm

All Web addresses cited were active at the time this document was published.

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3. U.S. Congress, Office of Technology Assessment, *Harmful Non-Indigenous Species.*
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7. Shanidar, "Medicinal Plants."
8. Root-Bernstein and Root-Bernstein, *Honey, Mud, Maggots.*
9. Bryan, *Papyrus Ebers.*
10. Root-Bernstein and Root-Bernstein, *Honey, Mud, Maggots.*
11. Tierra, *Herbal Tradition.*
12. Ibid.
13. *Introduction to the Middle Ages, Part 2.*
14. "Holistic Health Library–Glossary of Herbs" and "About–Herbal Extracts."
15. Hickman, "Onions."
16. Yoshida and others, "Organosulfur Compound"; Krest and Keusgen, "Stabilization"; Siegers and others, "Effects of Garlic Preparations"; Ismail, Gad, and Hamdy, "Study of the Hypolipidemic Properties"; Zink and Chaffin, "Herbal 'Health' Products"; and Dubick, "Historical Perspectives."
17. Mahon, "Traditional Dyestuffs in Ireland."
18. Clottes, "Rhinos and Lions and Bears."
19. "Dyes and Colors."
20. Ibid.
21. Abdulla, "Woad Wage."
22. Bellemare, "Local Colour."
23. Bussagli, *5000 Years of the Art of India.*
24. Grieve, *Modern Herbal.*
25. *Woad Wage.*
26. Thompson, Stuckey, and Thompson, *Spread, Impact and Control.*
27. Root-Bernstein and Root-Bernstein, *Honey, Mud, Maggots.*
28. Tyler, *Honest Herbal.*

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Glossary

Antibiotics are chemicals used to inhibit or destroy microorganisms.

Aromatherapy uses fragrant oils from plants to help mood and health.

Ayurveda is an ancient Indian approach to health. It teaches that your own body tells you how to eat right and have a healthy lifestyle.

Batik is a way of painting designs on a fabric with melted wax, dying the fabric, and repeating the process until the desired design is produced.

Capillary action refers to the attraction between the surface of a liquid and the surface of a solid. For example, when you put a paper towel in water, the water is attracted to the fibers in the towel. The water moves through the towel because of this attraction.

Carcinogens are substances that can cause cancer.

Chromatography is a way of separating the components of a mixture. Chromatography can be used to separate such varied substances as pigments in leaves, mixtures of drugs, or the compounds in natural products.

Estrogen refers to an entire class of steroids or hormones. Estrogens are often thought of as female hormones, but many are present in males as well. Estrogens are important in maturation and sexual functioning, and play a role in protecting the body from heart disease and osteoporosis.

Ethnobotany is the study of relationships between people and plants. Ethnobotanists study what native peoples know about the plants in their environment, particularly native uses of plants. They may study uses of plants as medicines, foods, dyes, fibers, and building materials.

Ethnopharmacology is a field that explores native uses of plants for healing.

Guild is a group of merchants, similar to a modern trade union.

Holistic medicine treats both the mind and the body.

Horticulture is the science of growing fruits, vegetables, and ornamental plants.

Insoluble is a substance that cannot be dissolved in a liquid.

Kente cloth is a colorful African cloth woven on a narrow loom. It is woven into a narrow strip. The patterns in kente cloth have specific cultural meanings.

Meditation uses contemplation, prayer, or spiritual study.

Mordants are chemicals used in dyeing to help the fabric retain color. All natural dyes fade over time. Mordants help reduce fading or "bleeding" of the color.

Neanderthal is an extinct hominid species that lived at the same time as early humans in Europe, northern Africa, and Asia. We do not know for sure if or how they are related to humans.

pH is a measure of acidity.

Sachet (sa-shay) is a small bag, sometimes containing perfume and/or dried plant materials, used to scent clothes and linens.

Search engine is a software tool that lets you search the World Wide Web for information. Common search engines include AltaVista, WebCrawler, Hotbot, Infoseek, and Excite.

Solvent is a substance that dissolves certain other substances. Water is a good solvent for many substances.

Tannin, a substance found in some plants, is used in tanning, dyeing, and to make ink. It also has medical uses.

Yoga is a way of exercise that helps both body and mind.

Food for Thought

The Science of Nutrition

Introduction

This project helps learners understand dietary guidelines and study their own eating habits. Young people will learn that food is a common denominator in many human experiences. Even though we all require basic nutrition, what we need depends on how active we are, how old we are, our reproductive status, and other factors. Where and how people live affects what they eat.

Project activities help young people learn about the sciences of health and nutrition. They also learn the mathematics of making estimates and comparisons as they read charts, graphs, and nutritional labels. They estimate portion sizes and amounts, and compare their own diets with USDA recommendations. Project activities include constructing food pyramids, comparing food labels, making soda, graphing nutrients, and planning meals. Many young people in North America may be surprised to learn that even though they eat plenty of food, their diets can be nutritionally poor.

Food for Thought invites learners to look at their own lives and realize that their choices impact their health. Making wise choices requires knowledge. Young people learn to seek information from a variety of sources and to make choices based on the best available information. They learn to value and respect the knowledge of parents and school workers, who are often in charge of what they eat. Studying the importance of healthy eating can help young people value meal planning and preparation skills.

This project explores the roles of culture, ecology, geography, climate, and sociology in diet and nutrition. Learners study recipes, meals, and diets that demonstrate the wide variety of food around the world. They begin to realize the many different ways people can put foods together to meet nutritional requirements. Learners find that preparing and sharing food is linked to cultural and social practices. It is a way of taking care of others. It creates and maintains relationships in social, civic, and religious life. When we "break bread" we express caring and sharing. We do this in such activities as business lunches, dinner dates, or religious ceremonies.

Cautions

Studies of nutrition should not reinforce negative body images or encourage unhealthy eating habits. Popular media encourages young people, particularly young girls, to be very critical of their body image. At the same time, advertisers encourage them to eat foods high in sugar and fat. Activities should not make calories the enemy. They should stress the benefits of healthy eating and living. Only one activity focuses on caloric intake and requirements.

Community Connections

This project should use the community as a resource. It should also be a resource for the community. Learners should talk to doctors and nutritionists to learn about local food-related illnesses and to better understand their work. Visit the kitchen of a hospital, retirement community, or school. Ask the staff about meeting the nutritional needs of a variety of clients. Visit or write to chain restaurants to gather information on the nutritional values of the foods they offer. Talk to a chef about balancing good nutrition and taste in restaurant menus.

After learners complete some of the earlier activities in the project guide, they may want to pool and analyze food diaries for a week. They can then summarize their results and look for nutritional gaps and problems. They can write an article for the local or school paper, or create a group newsletter. This way they can share findings and give advice to their peers. They may want to develop a nutrition pledge to share with their peers and families.

Many state and national organizations collect data related to community health. Learners may choose to find local health data for illnesses such as diabetes, heart disease, and cancer. They can use what they learn about diet-related illnesses to make people more aware of local health concerns. They can also give advice on how to improve local diets.

Activities: Brief Descriptions

Activity 1: Building and Using the Food Pyramid. This introduction to the food pyramid engages learners in looking at the nutritional makeup of some foods they are likely to eat. Learners put together a 3-D pyramid, which they use as a reference throughout the project.

Activity 2: How Much Sugar Is in My Soda? Starch in My Bread? Learn about the composition of some familiar foods through making soda and testing foods for starch and Vitamin C.

Activity 3: Ants on a Log? Yummy! Learners get hands-on experience in making interesting and nutritious snacks. They are challenged to invent their own snack recipes.

Activity 4: Is There Fat in My Food? Learn to do a simple test for fats. Discuss if you should eat foods with fake fats.

Activity 5: Food to Burn? Learners have a hot time measuring the calorie value of some common foods.

Activity 6: How Many Calories Do You Need? Learners estimate their own calorie requirements. They discover whether they need to make changes in their lifestyle.

Activity 7: Comparing Fast Foods. Where can you get the healthiest fast food meal in town? Learners use their math skills to compare what they are eating at various chain restaurants.

Activity 8: Nutrition Detectives. Food labels have a lot of useful information—if you know how to decode them. Learners use a number of criteria to decide which prepared foods are the most healthful.

Activity 9: Recipes for Health. This activity brings together what young people have learned about nutrition—and spices the information with connections to a variety of cuisines.

Activity 10: It Couldn't Happen Here! Diet, Health, and My Community asks young people to research diet-related illnesses in their own communities. They can then take action through a community education program.

Why Study Nutrition?

Benefits to Learners

Nutrition is important to everyone, regardless of age, gender, social or economic standing, or background. In the United States, most people have access to enough food, but that doesn't mean they are healthy. Many people make poor nutritional choices. In our society, junk foods are common, and advertisers often target the preteen and teen markets. Teens are keenly interested in how their bodies look and act. But their culture encourages them to eat fast foods and snacks. They are building habits they may carry through life. So, early adolescence is a prime time for helping children make informed choices about what they eat.

Through this project, young people can make a difference. They learn about the widespread problem of nutrition-related illnesses as they study American eating habits. By telling others how culture and diet affect health, they can help us make better choices.

Researching nutrition blends the art of preparing food with a variety of topics: science, mathematics, history, sociology, and geography. The study of nutrition explores various cultures and shows how diets relate to geography and climate. It lets learners consider a variety of career options.

Skills. This project helps learners develop skills they can use throughout life:

- measuring and estimating
- graphing
- interpreting charts and tables
- calculating calories, grams, and servings

- making comparisons
- collecting and analyzing data
- keeping records
- making public presentations

Topics and concepts. Learners gain knowledge that helps them better understand science and nutrition:

- the food pyramid, daily nutritional requirements, and nutrition data keeping
- good nutritional selections
- cultural contexts of foods and seasonings
- fats, carbohydrates, vitamins, and the roles these nutrients play in a healthy diet
- decoding nutrition labels
- planning nutritious meals and snacks
- calories and calorimetry
- chemical composition of foods
- comparing foods on a variety of nutritional criteria
- diet-related diseases

Career links. Learners should become aware of the many careers in nutrition and food science. Medical professionals, developers of new foods, and many other professionals need a strong background in the science of nutrition. Likewise, dieticians, caterers, nutritionists, and chefs need a background in science and mathematics. Nutritional testing, food chemistry, food packaging technology, and food inspection are potential well-paying career areas. Other nutrition-related careers combine science with communication skills: food journalism, food history, restaurant review, and television/radio food show production.

Compliance with national standards. This project addresses the following National Standards for Science for grades 5-8:

Content Standard A: Science as Inquiry

- Use mathematics in scientific inquiry

Content Standard F: Science in Personal and Social Perspectives

- Personal health

The project also addresses these National Council of Teachers of Mathematics Curriculum Standards for grades 5-8:

Standard 4: Mathematical Connections

- Explore problems and describe results using graphical, numerical, physical, algebraic, and verbal mathematical models or representations
- Apply mathematical thinking and modeling to solve problems that arise in other disciplines

Standard 5: Number and Number Relationships

- Represent numerical relationships in one- and two-dimensional graphs

Standard 7: Computation and Estimation

- Use computation, estimation, and proportions to solve problems

Standard 8: Patterns and Functions

- Describe and represent relationships with tables, graphs, and rules

Standard 13: Measurement

- Estimation

Benefits to the Community

Nutrition is a personal and family issue. But in this era of rising health care costs, a study of nutrition can benefit the whole community. This project can help people avoid diet-related illnesses such as diabetes, heart disease, atherosclerosis, various types of cancer, or osteoporosis. This can reduce the burden on community health care resources.

Young people should share their findings with the public. This may inspire others in the community to make dietary changes. What participants learn in this project may be of special value to other young people, who are more likely to accept advice from their peers than from adults. Learning about misconceptions and the way media influences diets can help teens become smarter consumers.

How can young people share their research findings with the community? They can have nutrition/health fairs or exhibitions. They can write articles in the local newspaper. They can put displays in local stores, community centers, or places of worship. They can offer nutrition lessons for younger children. As they plan, advertise, and organize these events, learners can sharpen many skills. They become better citizens as well as better scholars.

Ideas for Additional Projects

Nutrition is rich with research opportunities because it connects easily to science and social studies. Encourage learners to sample some of the books listed later in this project guide. They may become interested in one of the following topics.

Different Types of Diets

Your group may want to explore a variety of diets: diabetic diets, kosher diets, vegetarianism, vegan diets, macrobiotics, various sports diets, paleolithic diets, Ayurvedic diets, various historic or religious diets, or any of the hundreds of weight loss diets. What are the advantages of the particular diets? The disadvantages? The nutritional effects? How do they affect the teenage lifestyle? Which diets are quackery (have no benefits or are harmful)?

The Chemical Composition of Various Foods

We may think of fruits and vegetables as naturally healthy. But common foods contain thousands of chemicals that have differing physiological effects. Use the Internet to study the naturally occurring chemicals in food and learn their possible effects. For example, tomato plants contain over 240 chemicals. More than 80 of these chemicals are biologically active. They include naturally produced insecticides and pesticides, cancer preventatives, carcinogens (cancer-causing agents), sedatives, and stimulants.[1] Most people do not know how many chemicals are in food and do not know that many common foods have not been well tested for safety. Learners can use the Agricultural Research Services phytochemical and ethnobotanical databases at http://www.ars-grin.gov/duke/ to explore the chemical composition of foods and the idea of "food as medicine." Here is an interesting social studies activity: do some research, and list the chemicals in a common food item. Do a survey. Find out how many people are willing to eat the food that contains those chemicals!

Ethnicity, Place, and Health

Some health-related problems are particularly common in certain cultures, geographic areas, or ethnic groups. Some of these problems may be related to nutrition. Use the Internet or library to explore relationships among geography, ethnicity, and nutrition-related illnesses. A good source of on-line information about health and ethnicity is maintained at http://www.eatethnic.com/HealthData.htm.

University and state health service Web sites are good places to look for data by geographic region.

The Impact of Nutrition on History

Nutrition has had an impact on history. Scurvy, talked about in Activity 3, is one famous example of the ways that food has shaped our world.

Readings for Young People

Beatty, Monica Driscoll. *My Sister Rose Has Diabetes*. Illustrated by Kathy Parkinson. Ages 9-12. Santa Fe, NM: Health Press, 1997

Brown, Laurie Krasny. *Dinosaurs Alive and Well! A Guide to Good Health*. Illustrated by Marc Tolon Brown. Ages 4-8. Boston: Little, Brown, 1990.

Buchanan, Peggy. *Movin' and Groovin': Fun Exercises to Do Any Time and Any Place—Plus Nutrition Tips, Yummy Recipes, and More!* Illustrated by Kelly Kennedy. Ages 9-12. Santa Barbara, CA: Learning Works, 1997.

Buono, Anthony, and Roy Nemerson. *The Race Against Junk Food Starring the Snak Posse*. Illustrated by Denny Fincke. Ages 4-8. Yorktown Heights, NY: HCom, 1997.

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Burns, Marilyn. *Good for Me! All About Food in 32 Bites.* Illustrated by Sandy Clifford. Ages 9-12. Boston: Little, Brown, 1978.

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Figtree, Dale. *Eat Smart: A Guide to Good Health for Kids.* Ages: young adult. Clinton, NJ: New Win, 1992.

Goble, Paul. *The Return of the Buffaloes: A Plains Indian Story about Famine & Renewal on Earth.* Ages 9-12. Washington, DC: National Geographic Society, 1996.

Hirschi, Ron. *People of Salmon and Cedar.* Illustrated by Deborah Cooper. Photography by Edward S. Curtis. Ages: young adult. New York: Cobblehill Books, 1996.

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Martell, Hazel Mary. *Food & Feasts With the Vikings (Food & Feasts).* Ages 9-12. Parsippany, NJ: Silver Burdett, 1995.

Miller, Judy. *Grilled Cheese at Four O'Clock in the Morning.* Illustrated by Jeanne Turner. Ages 9-12. Alexandria, VA: American Diabetes Association, 1996.

Peacock, Carol Antoinette, and Adair Gregory. *Sugar Was My Best Food: Diabetes and Me.* Illustrated by Kyle Carney Gregory and Mary Jones. Ages 9-12. Morton Grove, IL: Whitman, 1998.

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Regguinti, Gordon. *The Sacred Harvest: Ojibway Wild Rice Gathering (We Are Still Here: Native Americans Today).* Ages 9-12. Minneapolis: Lerner, 1992.

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Leader Background Information

Food, History, and Culture

Olives are one of the oldest cultivated fruits. They were highly regarded in the ancient Mediterranean region. Egyptians considered olive oil sacred. Greeks called it "liquid gold" and thought olives were the most important gift from the gods.[2] Sumerians used it to anoint their bodies as well as their foods. Many cultures have special foods for holidays and other rituals. Many have festivals that celebrate harvest and abundance. Today we eat sugary *funnel cakes* at fairs. When we do, we are participating in an ancient custom of eating deep-fried foods at festivals. The practice began with the need to use up animal fats in *pre-Lenten* festivals. It was handed down through Amish and German tradition.

Knowledge and preferences about food change over time and in different places. Long-distance trade in foods has gone on for centuries. The Portugese brought the idea of deep-frying food to Japan. This led to the development of *tempura*.[3] Tomato sauce is used in many Italian foods, but tomatoes came from the New World. Much exploration happened as a way to get spices more cheaply. Chocolate is now loved around the world but was unknown outside Mexico until the sixteenth century.[4] Libyan cuisine combines Arabic, Mediterranean, and Italian foods. This is because the country was once an Italian colony.[5] *Creole* cooking is a mixture of Native American, Spanish, and Southern foods. Peas, okra, yams, and peanuts—foods native to Africa—are part of Southern cooking. Hominy and grits came from the Native Americans.[6]

New knowledge or marketing efforts may bring new foods into favor. Tomatoes were once thought to be poisonous and were grown primarily as flowers. It was not until the mid-1800s that they became widely eaten. We now consider lobster a luxury. It was once a "trash" food, fit only for the poor.[7] For generations caviar was considered unfit to sell.[8] It was eaten primarily by fishermen, who sold the "good" parts of the fish. Polenta, a filling cornmeal dish, was a staple of peasant diets. Now it is a gourmet treat.[9] Rye and oats were once considered weeds. Yogurt has only recently become popular in the United States. It has been eaten around the world for more than 4,000 years.

Several species of fish have been given different names (often called marketing names) that make them sound more appealing. For example, the popular orange roughy was once known as the slimehead.[10] The red mullet was formerly the goatfish.[11] What we call the monkfish was once called the frogfish, bellyfish, sea devil, or allmouth.[12] The slimy mackerel's marketing name is the blue mackerel.[13]

< Definitions

Funnel cakes are a deep-fried pastry, served with powdered sugar on top. They are often sold at fairs and special events.

Tempura is a type of Japanese food. Most often, tempura is seafood or vegetables coated in batter and fried in deep fat.

Creole refers to a culture, language, and cuisine found in southern Louisiana that evolved from French, Spanish, and African roots.

Lent is a 40-day period of fasting and repentance observed by some Christian churches.

Activity 1

Building and Using the Food Pyramid

Leader Notes

This activity introduces nutrition and the food pyramid. Each learner makes a 3-D model of the food pyramid. It shows how many daily servings of each food group we should have and gives information on serving sizes. It is based on USDA dietary guidelines for good health.

The Real Foods Challenge helps learners to use their knowledge in a concrete way. Players determine the number of servings from different pyramid groups found in prepared foods. They practice estimation skills, counting, and fractions. They also learn nutrition facts.

Key Question

- What types and amounts of foods do I need to eat each day to be healthy?

Building the Food Pyramid

Directions for building a three-dimensional food pyramid are in Handout 1-1. (Directions are very simple. You may want to provide them verbally rather than copy the handout.) The easy-to-copy pattern for the sides of the pyramid is found in Handouts 1-2 and 1-3. Before doing this activity, copy both pages on card stock or heavy paper. Handout 1-4 is a sample format for a learner's food log. Use the handout or have learners design their own food log.

Taking the Real Foods Challenge

Directions for playing the Real Foods Challenge are in Handout 1-5.

Copy the Real Foods Chart (Handout 1-6) for students.

Copy and cut out the food item description from the Breakfast Bowl Items

Materials Checklist

☐ 3-D food pyramid directions (Handout 1-1) (optional—1 copy per learner)

☐ 3-D food pyramid (Handouts 1-2 and 1-3) (1 set per learner, copied on card stock or heavy paper)

☐ Colored pencils or markers (1 set for every 4 learners)

☐ Scissors (1 pair for every 4 learners)

☐ Glue or rubber cement (1 bottle for every 4 learners)

☐ Tape (1 roll for every 4 learners)

☐ Handouts 1-5 and 1-6 (1 copy per learner)

☐ Copies of Handouts 1-7 and 1-8 (1 copy for every 8 learners)

Approximate Time Required

Introducing topic and making 3-D food pyramid, 20 minutes

Keeping food log, 10 minutes per day—can be outside of meeting time

Analyzing food log, 40 minutes

Real Foods Challenge, 30 minutes to 1 hour

Environmental Note

Recycle paper when activity is complete.

What to Do in Advance

☐ Copy food pyramid (Handouts 1-2 and 1-3) on card stock. Copy directions (Handout 1-1) on paper (optional).

☐ Gather materials.

☐ Copy handouts and food slips for Real Foods Challenge. Cut out food slips.

☐ Bring in reference books or cookbooks with serving size information.

(Handout 1-7) and Lunch Box Items (Handout 1-8). Some blank slips are included so that learners can make their own "real foods" to add to the mix.

Make sure that you have enough slips of paper for each learner to take one breakfast item and one lunch item. Put the slips of paper in two envelopes or boxes (one for breakfast items, one for lunch items). Have players draw one item from each category. If they draw a blank slip, they should write their own item. After learners have completed their menus, discuss the activity. Ask them if they were surprised by anything they found. Ask if it was difficult to estimate the number of servings of different items in the food.

For those who have access to a computer, there are a number of software-based nutritional games. They challenge learners to choose healthy snacks or plan their diets. They are a fun way to combine technology and nutrition. Dozens of such games are available for free on the Internet. Some examples are as follows:

On-Line Nutrition Games

The Healthy Fridge quiz—http://www.healthyfridge.org/kids.html

Build your own pyramid—http://www.kidsfood.org/f_pyramid/pyramid.html

Pyramid Power—http://www.greengiant.com/gg/games/pyramid.html

Rate your plate!—http://www.kidsfood.org/rate_plate/rate.html

Size up your Servings—http://www.nutritioncamp.com/learning/index.html

Winning Choices!—http://www.kidsfood.org/choices/winning/winning.html

Make your Plate Proud—http://www.nutritioncamp.com/learning/index.html

Have a Bite—http://exhibits.pacsci.org/nutrition/cafe/cafe.html

Veggie Scramble—http://www.greengiant.com/gg/games/scramble.html

Grab a Grape—http://exhibits.pacsci.org/nutrition/grape/grape.html

Dairy Puzzle—http://www.milk.mb.ca/Nutritin/kids/dpuzzle.htm

Cyber Food Shopper—http://www.kidsfood.org/choices/shopper.html

Nutrition Sleuths—http://www.kidsfood.org/sleuths/work_sh.html

Nutrition Sleuth—http://exhibits.pacsci.org/nutrition/sleuth/sleuth.html

Five a Day Game—http://www.dole5aday.com/menu/kids/menu.htm

Calisthenics Calculator—http://www.nutritioncamp.com/learning/index.html

Ask learners to (1) design a menu for a restaurant that sells only healthy foods, (2) develop a healthy frozen dinner, or (3) plan healthy menus for a day or a week. This will help you determine if they understand the basics of a healthy diet.

Activity 2

Ants on a Log? Yummy!

Leader Notes

Give learners hands-on experience in fun and nutritious snacking. Make Apple Smiles, Ants on a Log, and Gorp. This activity is great for break or snack time. Make sure learners wash their hands before—and after—this one. Have plenty of clean rags nearby!

Key Questions

- What makes a snack healthy?
- What are some simple ways I can increase the nutritional value of my snacking?
- If I want to make healthy and appealing snacks for my friends, what do I need to consider?

Procedure

Instructions for making the snacks are found in Handout 2-1.

Note that foods may be healthy in moderation. Too much of any one food can be bad for you. For example, peanut butter is an excellent source of protein but is quite high in fat. To cut down on fats, learners can make the "Smiles" and the "Logs" with small amounts of peanut butter.

Tell learners they can make one of each item. Otherwise, you may run out of materials. If you want to allow for more than one "Smile" and "Log," bring extra ingredients.

If you precut the apples, sprinkle the slices with lemon juice. This will avoid discoloration. Store precut celery in cold water to maintain crispness.

After eating their snacks and cleaning up, ask learners to discuss the key questions. From their discussion, ask them to design

Materials Checklist

☐ Directions (Handout 2-1) (1 per learner)

Apple Smiles

☐ Red apples (1 apple per 8 learners)
☐ Peanut butter (1 teaspoon per learner)
☐ Miniature marshmallows (3 per learner)
☐ Paring knife (1 per 8 learners)
☐ Table knife (1 per 8 learners)
☐ Paper towel (at least 1 per learner)

Gorp

☐ Dry measuring cup (1/4 cup) (1)
☐ Ziploc® bag (1 per learner)
☐ Peanuts (1/4 cup per learner)
☐ Raisins (1/4 cup per learner)
☐ Sunflower seeds (1/8 cup per learner)

Ants on a Log

☐ Celery (1 stalk per two learners)
☐ Peanut butter (1 tablespoon per learner)
☐ Raisins (8-10 per learner)
☐ Clean rags (1 per learner)

Approximate Time Required

Making snacks, 30 minutes

Developing new snacks and writing recipes, 1 hour simple, healthful snacks that they could teach younger children to make. Collect everyone's "best" snack. Put them together to make a snack book to give out in the Nutrition Fair at the end of the project.

You may also want to have learners teach a younger group to make their snacks.

Environmental Notes

Eat any leftover foods.

Recycle leftover paper.

Wash rags for reuse.

What to Do in Advance

☐ Determine if any young people in your group have peanut or other food allergies. If they do, adjust activities accordingly.

☐ Assemble materials.

CAUTION

Safety Notes

1. If you are working with younger children or cannot use kitchen knives in your setting, prepare the celery and apples in advance.

2. Many young people have food allergies. Nuts and peanut butter, for example, can cause a fatal reaction to someone who is allergic to them. Before doing this activity, send a letter home with learners. List the foods that you will be using. Ask parents to contact you in advance if they have concerns about exposing their child to a particular food.

Activity 3

How Much Sugar Is in My Soda? Starch in My Bread?

Leader Notes

This activity helps learners understand the composition of familiar foods. They make their own orange soda. This can sharpen their measuring skills. They also learn how much sugar they consume when they have a soft drink. They test for the presence or absence of starches and vitamin C in their foods. This teaches them to use simple scientific procedures to test for nutrients.

Key Questions

- What are some tests I can use to find out about the nutritional content of foods?
- How does the body use sugars, starches, and vitamins?

Procedure

- Directions for the soda activity are found in Handout 3-1. The soda recipe is Handout 3-2
- You may want to have copies of the soda recipe available for learners to take home
- Have plenty of clean rags and a trash bag handy. There will be spills!
- Let learners finish their soda. Then ask them to calculate how much sugar there would be in a 12-ounce can of soda.
- Ask learners to (individually) calculate how many ounces of sugar they consume each day in soda. They will need to estimate the average number of ounces of soda they drink each day. Responses will vary

Directions and a data table for the starch test are found in Handouts 3-3 and 3-4. Ask learners to predict whether or not the various foods will contain starch before they do the starch tests.

Materials Checklist

Orange Soda

☐ Directions for soda activity (Handout 3-1) (1 per learner)
☐ Orange soda recipe (Handout 3-2) (1 per learner)
☐ Club soda (4 oz. [cup] per learner)
☐ Teaspoon—to measure sugar (1 per 8 learners)
☐ Spoon to measure orange extract (1/4-teaspoon size) (1 per 8 learners)
☐ Sugar (4 teaspoons per learner)
☐ Orange extract (1/4 teaspoon per learner)
☐ Red food coloring (1 drop per learner)
☐ Yellow food coloring (2 drops per learner)
☐ Measuring cup (cup size) (1 per 8 learners)
☐ Drinking cups (1 per learner)
☐ Spoons for stirring (1 per learner)

Testing for Starches

☐ Directions for starch test (Handout 3-3) (1 per learner)
☐ Starch Test Data Chart (Handout 3-4) (1 per learner)
☐ Tincture of iodine (1 bottle) Note: Tincture of iodine is available in most drugstores and in the pharmacy section of supermarkets.
☐ Dropper (1 per 8 learners)
☐ Cup or other container to hold diluted iodine solution (1 per 8 learners)
☐ Water (to dilute iodine)
☐ Small samples of various foods to test (suggested foods include breads, potatoes, cornstarch, crackers, rice, vegetables, fruits, candy, sugar, dried beans, yams, honey, green banana, ripe banana) Note: Make sure to pick foods that are relatively light in color. If the food item is too dark, color changes will not be obvious.
☐ Towels, plates, or napkins to hold food samples (1 per food item used)

Iodine can stain. You may want to spread out newspapers before doing the starch and vitamin C tests.

If possible, use ripe and unripe samples of the same fruit in the starch test. For example, have a ripe banana and a green one. Learners may be puzzled by the different results they get with green and ripe fruits. Remind them that starches are big molecules that break down into smaller sugar molecules. As fruit ripens, starch breaks down into sugar.

Discuss any differences between learners predictions and their test results.

Directions and a data table for vitamin C determinations are found in Handouts 3-5 and 3-6. Ask learners to predict whether a substance will contain vitamin C before they do the test.

To do the vitamin C test, you will need to make up the cornstarch solution in advance so it can cool. To make the solution, dissolve approximately one teaspoon of cornstarch in one cup of boiling water. This is enough for eight people to use; make more solution if you will have more people.

Environmental Note

Use reusable glass or plastic cups for holding liquids. This keeps paper cups from the landfill.

Materials Checklist (cont'd)

Testing for Vitamin C

- ☐ Directions for vitamin C test (Handout 3-5) (1 per learner)
- ☐ Tincture of iodine (1 bottle—you can use the same bottle that you used in the starch test)
- ☐ Scurvy preventer chart (Handout 3-6) (1 per learner)
- ☐ Dropper (1 for each food item)
- ☐ Cornstarch solution (1 teaspoon cornstarch dissolved in 1 cup boiling water per 8 learners)
- ☐ Samples of various nutrients and food juices to test (suggested foods include lemon juice, orange juice, commercial juice drinks, other fruit and vegetable juices, vitamin C tablets, sodas)
- ☐ Small glasses, cups, or test tubes to hold liquids (1 per food item used)

Approximate Time Required

Orange soda, 15 minutes

Starch test, 20-30 minutes

Vitamin C test, 20-30 minutes

Environmental Notes

Keep all food items sanitary for consumption (unless used for testing).

Use very small amounts of food for testing. This minimizes waste and disposal problems. Dispose of food with iodine on it in a way that young children or animals cannot get into it.

Recycle any leftover paper.

Tincture of iodine should be stored for later use.

Diluted iodine solutions can be washed down the drain.

Safety Note

Iodine is poisonous if eaten or swallowed. Do not do the starch and vitamin C tests with young children. Do not leave iodine where a young child or pet can get access to it.

Activity 4

Is There Fat in My Food?

Leader Notes

There are two parts in this activity. First, there is a simple test for fats in foods. Then, there is a fishbowl-type activity on the fake fat, olestra. The fats test uses common foods and a brown paper bag to mark the presence or absence of fats. This test is suitable for all age groups. The fishbowl portion of this activity introduces learners to olestra. Olestra is a nondigestible fat introduced in the United States in 1996. It is used in many chips and snack foods. The fishbowl requires reading articles, putting together information, and making recommendations. Therefore, it is more appropriate for teens and advanced preteens.

Key Questions

- What are fats? What is the function of fats in the body?
- How can I know if foods contain fats?
- What are the positive and negative effects of using products that contain fat substitutes?
- Should I eat products that contain fat substitutes?

Fats Test

Brown paper bags absorb *fats* from fat-containing foods. The absorbed fat changes the paper's *index of refraction* and makes the paper look wet. If there is fat, the paper becomes *translucent*. Thus, brown paper provides an easily visible test to determine whether fat is present. We have suggested some foods for this activity. Use the test on other food items as well. Choose items that your learners eat. This will maximize the impact of this activity. Directions for the Fats Test are found in Handout 4-1.

Materials Checklist

Fats test

- ☐ Directions (Handout 4-1) (1 per team)
- ☐ Brown paper bag (may be cut into squares) (1 per team)
- ☐ Variety of foods (enough for each team to have a small sample) Suggestions: potato chips, carrots, apples, nuts, bacon, biscuits, other baked goods. Ask learners to bring some of their own items to test.

Fishbowl

- ☐ Directions (Handout 4-2) (1 per team)
- ☐ Various articles on olestra (including those representing the industry's point of view and those critical of olestra) Note: Newspapers, magazines, and the World Wide Web provide information that may be useful.

Approximate Time Required

Fats test, 20 minutes

Fishbowl, 3 to 10 hours, depending on the amount of research done

Environmental Notes

Recycle leftover paper.

Dispose of food test items on compost pile or in trash.

What to Do in Advance

- ☐ Arrange for food items to test. You may want to have learners bring their own foods.
- ☐ In advance of the olestra fishbowl, you may want to bring in olestra-containing foods as well as articles or television segments on olestra.
- ☐ Arrange for learners to have access to library or Internet for research.

Fake Fats: A Fishbowl Activity

Go further into diet and fats through real-life decision making. Handout 4-2 outlines an activity on snack products and "fake fats."

Americans have tried to cut down on fat. This has inspired the development of nonabsorbable fats such as olestra (brand name Olean). Despite the availability of low-fat and fat-free foods, Americans as a group have not lost weight. Instead, obesity is on the rise. It is unclear whether new ingredients such as olestra will change this trend. Many people are concerned about potential health impacts of widespread use of olestra and other nondigestible products. There are national campaigns both for and against the use of olestra in snack products. There are many articles and resources available on its benefits and potential problems. (For example, promotional materials on olestra are featured at many food stores and restaurants.) Because young people eat many snack foods, a dialog on olestra helps them apply what they have learned about nutrition to real-life decision making. We suggest using a fishbowl format, where all participants can have their voices heard.

A fishbowl is a nonconfrontational activity in which part of the group (those in the "fishbowl") gets to talk about a controversial issue. The rest of the group sits in a circle surrounding the people in the fishbowl. Only people inside the fishbowl are allowed to talk. People outside the fishbowl must sit silently and listen. Later, the listeners get a chance to be in the fishbowl. Those who were in the fishbowl get a chance to listen.

Depending on the size of your group, you may put four to eight people inside the bowl. Ask for volunteers, or choose a group to be in the first fishbowl. Select equal numbers of learners who wish to speak for and against buying olestra-based snacks.

< Definitions

Fats are oily or greasy chemical compounds of carbon, hydrogen, and oxygen. Fats are energy-rich substances found in animals and plants.

The **index of refraction** is related to the different speeds that light travels in different substances. Things in the water aren't where we expect them to be. Light travels at different speeds in water than in air, and that makes a difference in how we see their location. In this activity, when fats are absorbed into the paper bag, the speed that light travels through the bag is changed.

Translucent objects let light pass through.

CAUTION

Safety Note

Many young people have food allergies. Nuts and peanut butter, for example, can cause a fatal reaction in someone who is allergic to them. Before doing this activity, send a letter home with learners listing the foods that you will be using and asking parents to contact you in advance if they have concerns about exposing their child to a particular food.

Ask the learners in the fishbowl to discuss the question while everyone else listens. Make sure all students inside the fishbowl are heard. Hold enough separate discussions so everyone gets a chance to be in the fishbowl.

Both supporters and opponents of olestra use scientific evidence and cite scientific studies. There are competing claims about the effects of olestra. Learners will read about the importance of other substances, such as *carotenoids*, in the human body. Learners need to think critically about what they hear. They will learn that some decisions must be based on incomplete and often contradictory information. They must weigh the risks and benefits of particular decisions. Handout 4-2 provides information about researching and discussing the topic.

< Definition

Carotenoids are a group of fat-soluble nutrients found primarily in fruits and vegetables. They are believed to help prevent disease and have numerous health benefits.

If you plan to access the Internet for recipes or research, make sure you have parental permission (in writing) to do so. It is important that you closely monitor use. Do not let learners go to sites that are off-task or objectionable. If you are accessing the Internet in school, make sure that you comply with all policies on student Internet use.

Activity 5

Help! I'm Burning My Food! Measuring Calories in Common Foods

Leader Notes

Food is stored chemical *energy*. Plants use solar energy (sunlight) to produce complex molecules such as carbohydrates, fats, and proteins. The *chemical bonds* in these molecules store energy. Energy is converted to a usable form by breaking these chemical bonds and forming new bonds. The bond-forming process releases energy. Our bodies release energy slowly through a series of chemical reactions.

In this activity, learners find the *caloric* content of several common foods by measuring the heat given off when we burn them. The more calories a food has, the more heat it will produce when burned. We can measure this energy by measuring the increase in the temperature of water that is heated by burning samples of food. From this change in temperature, we can calculate calorie values.

Fats, carbohydrates, and proteins contain different amounts of energy. Each *gram* of carbohydrate provides about 4 Cal of energy. A gram of protein provides 4 Cal of energy. A gram of fat provides 9 Cal of energy.

< Definitions

Energy is the capacity for doing work. There are many forms of energy, including solar energy, chemical energy, geothermal energy, wind energy, and nuclear energy.

A **calorie** is a measurement unit of heat. It is the amount of heat required to raise the temperature of one gram of water by a temperature of one degree Celsius. This amount of heat is called a small calorie, and is written with a small c. The unit we use when measuring the energy content of food is called a kilocalorie or a big calorie, and its abbreviation (Cal) is written with a large C. One Cal is equal to 1000 calories.

A **gram** is a unit of mass. A nickel weighs about 5 grams.

Molecules are generally defined as the smallest particles of a substance that retain all the properties of the substance. Molecules are made up of atoms, chemically bonded together.

Atoms are the smallest particle of an element that can exist. Atoms may exist alone or in combination with other atoms, forming a molecule.

The term **chemical bond** is a way of thinking about the forces that hold atoms together in molecules.

Notes

Activity 5 has two versions—5A and 5B. Version A is for informal education groups or groups that don't have access to a school lab or scientific equipment. Version B is for groups that have access to lab equipment and for groups who want to learn more about measuring calories and the calorie content of different foods. Choose the version you will use. Base your choice on the equipment you have available, the goals and needs of your group, and leader comfort with the science and mathematics involved.

Activity 5A

Help! I'm Burning My Food! Measuring Calories in Common Foods (for Informal Education Settings)

Key Questions

- Would this method work for determining the calorie content of all foods? Why or why not? What might you have to change to make it work for other foods?
- Were any of the calorie values particularly surprising? Why or why not?

Setting Up the Experiment

You can set up this activity in different ways depending on the materials you have available. You need some way to fasten food samples to a nonflammable holder. You need a way of safely suspending a cup or beaker of water above the flaming food sample. And you need a way to ignite the food sample. Use what you have at hand. You don't need special equipment. But make sure that the water and flaming food samples are secure. Make sure they are not going to burn learners or catch anything on fire.

Use baby food containers, Pyrex cups, or small jars to hold water. Just make sure that your container is nonflammable and can withstand heat. Secure the food sample with a cork, lump of clay, thick slice of potato, or a similarly firm, dense substance. Use bricks and metal screen wire to suspend the water container over the food sample. Ignite the food with a lighter or a match.

Another way to set up the experiment is to hang a small tin can inside a larger one. Punch holes near the bottom of the larger can so air can get to the food sample. If you try this, make sure that there are no sharp edges on the cans!

If you have access to science laboratory

Materials Checklist

Materials will vary depending on the setup you use and how many foods learners test. This is a sample list:

☐ Large sewing needles, craft pins, long nails or metal skewers (1 per learner or team), cork, chunk of clay, thick slice of potato or some other substance to serve as a base to hold the needle or nail (1 per learner or team)

Samples of foods to test:

☐ Peanuts, popped popcorn, many snack foods, and various nuts—foods with high oil and low water content work well (also try miniature marshmallows) (3-4 small samples per learner or team)

☐ Containers for heating water: a beaker, Pyrex® measuring cup, baby food container, or small sturdy glass jar (1 per learner or team)

☐ Materials for suspending water container above flame (see *Setting up the Experiment* below to decide what to use)

☐ Matches, lighter, Bunsen burner, or other method for setting the food on fire

☐ Thermometers (optional, 1 per learner)

☐ Handout 5-1A (1 per learner)

equipment, you can use a ring stand or tripod and wire gauze to hold a beaker of water above the food sample.

The Activity

Directions for the activity are found in Handout 5-1A. Experiment with a variety of foods. See what types of food burn best using this method.

The day before, or earlier in the day of the activity, set out jugs or containers of water. Let the water come to room temperature so it will be easier to notice temperature differences between the heated and the unheated water.

Remind learners that the amount of heat produced in burning the food samples is at least as great as that produced when the food is burned in their bodies!

Encourage learners to think about the activity they just did. They can use the Key Questions. You might ask them if the method would work for liquid foods or for other foods with a high moisture content. Ask them how they might find the calorie content of soda pop. (They should come up with ideas such as finding the calorie content of the ingredients separately.)

Approximate Time Required

30 minutes

Environmental Notes

Ashes can be put on a compost pile or in trash.

Recycle used paper.

Other materials should be saved for future use.

What to Do in Advance

☐ Make sure that none of the learners in your group have food allergies. If any do, do not use problem foods in this activity.
☐ Determine how you will suspend the water above the burning food.
☐ Put together a sample setup to demonstrate the procedure to learners.
☐ Set aside container(s) of water so the water can come to room temperature.
☐ Gather materials and food samples.
☐ Copy Handout 5-1A.

Activity 5B

Help! I'm Burning My Food! Measuring Calories in Common Foods (for Classroom Settings or Further Exploration)

Key Questions

- How do the calorie values you obtained differ from those found in tables? Why do you think they are different?
- What could you change in your experiment to obtain more accurate values?
- Would this method work for determining the calorie content of all foods? Why or why not? What might you have to change to make it work for other foods?
- Were any of the calorie values particularly surprising? Why or why not?

Setting Up the Experiment

You can set up this activity several different ways depending upon the materials you have available. You need some way to fasten food samples to a nonflammable holder, a way of safely suspending a cup or beaker of water above the flaming food sample, and a way to ignite the food sample. Use what you have at hand, but make sure that the water and flaming food samples are secure and are not going to burn learners or catch anything on fire.

If you have access to science laboratory equipment, you can use a ring stand or tripod and wire gauze to hold a beaker of water above the food sample. Skewer the food sample on a needle, long pin, or nail, and insert it into a cork. You can ignite the food sample with a Bunsen burner.

If you do not have lab equipment available, you can use baby food containers, Pyrex cups, or small jars instead of beakers. Just make sure that your container is nonflammable and can withstand heat. Secure the food sample with a cork, lump of clay, or thick slice of potato or similarly

Materials Checklist

Materials will vary depending on the setup you use and how many trials learners do. This is a sample list:

- ☐ Large sewing needles, craft pins, long nails or metal skewers, and cork, chunk of clay, thick slice of potato, or some other substance to serve as a base to hold the needle or nail (1 per learner or team)

Samples of foods to test:

- ☐ Peanuts, popped popcorn, many snack foods, and various nuts—foods with high oil and low water content work well (also try miniature marshmallows) (3-4 small samples per learner or team)
- ☐ Containers for heating water: a beaker, Pyrex® measuring cup, baby food container, or small sturdy glass jar (1 per learner or team)
- ☐ Materials for suspending water container above flame (see *Setting up the Experiment* below to decide what to use)
- ☐ Matches, lighter, Bunsen burner, or other method for setting food on fire
- ☐ Thermometers (1 per learner or team)
- ☐ Balance for weighing food and water
- ☐ Calculators (1 per 3 learners or teams)
- ☐ Pencils (1 per learner or team)
- ☐ Handout 5-1B (1 per learner)
- ☐ Handout 5-2B (1 per team per set of trials)

firm, dense substance. Use bricks and metal screen wire to suspend the water container over the food sample. Ignite the food with a lighter or a match.

There is another way to set up this experiment. Hang a small tin can inside a larger one. Punch holes near the bottom of the larger can. This lets air get to the food sample. If you try this, make sure that there are no sharp edges on the cans!

The Activity

Directions for the activity are found in Handouts 5-1B or 5-2B. Handout 5-2 is a data table that details how to convert a change in water temperature to a calorie value for the food. Do at least three trials with one type of food. Get an average calorie value. Then experiment with other foods. See what will burn well using this method. Learners will need data tables for each set of trials they do

The day before, or earlier in the day of the activity, set out jugs of water. Let the water come to room temperature. This will minimize temperature shifts due to differences between water temperature and room temperature.

Learners will get lower values than those found with professional equipment and procedures. Let learners do their calculations, then compare them to generally accepted values. Ask them to discuss what factors would tend to make their values low. (These will include the amount of heat generated that does not go into the water, heat that is lost to the environment due to cooling of the water, lag time in getting the food sample under the water, other heat losses, measurement errors, lack of precision in measuring equipment, etc.) This discussion may lead to serious thought about the experiment.

Remind learners that the amount of heat produced in burning the food samples is at least as great as that produced when the food is burned in their bodies!

Approximate Time Required

1 hour

Environmental Notes

Ashes can be put on a compost pile or in trash.

Recycle used paper.

Other materials should be saved for future use.

What to Do in Advance

☐ Make sure that none of the learners in your group have food allergies. If any do, do not use problem foods in this activity.
☐ Determine how you will suspend the water above the burning food.
☐ Put together a sample setup to demonstrate the procedure to learners.
☐ Set out container(s) of water so the water can come to room temperature.
☐ Gather materials and food samples.
☐ Copy Handouts 5-1B and 5-2B.

Activity 6

How Many Calories Do You Need?

Leader Notes

In this activity, learners study their personal calorie requirements. They learn how many calories they consume each day. Learners calculate the calories they need each day, based on their activity level. Then they compare this number to the number of calories they consumed the day before. They also take a critical look at food advertisements and consider other factors that may encourage them to eat unhealthy foods.

Key Questions

- How many calories do I need each day to keep my health and energy?
- How are my activity level and eating habits related to my optimal calorie intake?
- What are some things around me that encourage me to eat more calories than I need? How can I resist these factors?

Leader Notes

Begin the activity with an informal study of advertising. Look at how food, snacks, and restaurants are promoted. Bring and share examples of television commercials, magazine ads, catalogs, flyers, or other attempts to sell food. Ask learners to bring food ads from magazines, papers, television, or radio. Then ask learners to evaluate the advertisements based on these factors:

- accuracy
- relationship between the ad and food (For example, does the ad focus on sports, popularity, looks, media tie-ins, music, fun—or on the food itself?)
- claims being made for the food (What does the ad say it offers in terms of taste, nutrition, health, sports success, popularity, sex appeal, good looks, prizes, etc.?)
- targeted audience (Is it children, teens, adults, the elderly? How do you know?)

Materials Checklist

- ☐ Directions (Handout 6-1) (1 copy per learner)
- ☐ Work sheet (Handout 6-2) (1 copy per learner)
- ☐ Pencils (1 per learner)
- ☐ Calculators (1 per 2 learners)
- ☐ Calorie charts (1 per 2 learners)

Approximate Times Required

Calorie work sheet, 20 minutes

Media image study, 30 minutes to 1 hour

Environmental Note

Recycle all paper.

What to Do in Advance

- ☐ Copy Handouts 6-1 and 6-2.
- ☐ Gather calorie charts or arrange for library or Internet access to calorie charts.
- ☐ Bring in, or have learners bring in, food advertisements and commercials.

- devices used to grab your attention (Does the ad use celebrity spokespersons, music, graphics, athletics, or sex appeal? Are these hooks successful?)
- suggestions about appearance (What does the ad suggest teens should look like? How should they dress? What should they be consuming, other than the item being sold?)

Your learners may attend schools that show television programs and ads to students. You may want to tape some of the ads. Many schools have free posters and magazines that contain ads that directly target teens. They are good sources for critiques.

After learners critique these ads, you may want to have them create their own "anti-ads." See the magazine *Adbusters* or the Adbusters Web site at http://www.adbusters.org/main/index.html. These are rich sources of ideas for anti-ads and un-commercials. They also suggest ways to challenge a culture that encourages teens to consume products that may not be healthy or beneficial.

The caloric requirements section of the activity is described in Handout 6-1.

Handout 6-2 is a work sheet for learner use.

This part of the activity should be done individually. It should be done with care so learners can maintain their privacy. Many teens are very sensitive about their body image and activity level.

Remind learners that they are making approximations, not getting exact numbers. Metabolisms vary. So do the way individuals think about their activity levels. The calories in foods vary depending on how they are prepared. This exercise gives learners ballpark numbers for comparison. It does not give strict quotas.

Learners will need copies of calorie charts. These can be found on-line, in health and nutrition books, in cookbooks, and in many magazines.

CAUTION

Safety Note

Do not reinforce negative body images. Do not encourage unhealthy forms of dieting. Do not make calories the enemy. Instead, stress the benefits of nutritious eating for a healthy lifestyle.

Activity 7

Comparing Fast Foods

Leader Notes

In this activity, learners explore the nutritional content of various fast foods by making graphs and interpreting charts. Learners select a food, such as cheeseburgers, and use reference material to find the nutritional content. Then they graph data on fat, sodium, salt, and calories for their food as it is served by different fast food restaurants.

Key Questions

- What is the healthiest fast food in town?
- What are some nutritional factors I should consider when choosing fast foods?
- How can I compare nutritional information for different foods?

This activity can be done individually or in teams. Directions are found in Handout 7-1.

Some learners may not have experience with graphs. They may have questions about the type of scale they should use or how they should construct their graphs. There may be false starts before their graphs do a good job of showing differences among restaurants. This is an important part of the learning process. However, if you have limited time, you may want to use predetermined scales. Try to monitor the graphing process. If learners are using inappropriate scales, catch it early.

In advance of the activity, copy and cut up the strips representing various fast food items that are found in Handout 7-2. Put these strips in an envelope or jar for learners to draw from for the activity.

This activity requires charts displaying the nutritional content of various fast foods. You may obtain these charts in a number of different ways:

Materials Checklist

- ☐ Directions (Handout 7-1) (1 per learner)
- ☐ Markers of several colors (1 set per 8 learners)
- ☐ Yardsticks (1 per 4 learners)
- ☐ Easel paper (3 sheets per team, plus extras)
- ☐ Tape (1 roll)
- ☐ Nutritional information on various fast foods (1 copy per learner)
- ☐ Table to record nutritional information (1 copy per team) (Handout 7-2)
- ☐ Food item slip (1 slip per learner copied from Handout 7-3)

Approximate Time Required

If using restaurant tables, 40 minutes

If using Internet, 1 hour

Environmental Note

Recycle paper when finished.

What to Do in Advance

- ☐ Obtain fast food nutrition data (from restaurants, the Internet, the Dairy Council, or other sources).
- ☐ If learners are to use the Internet, make arrangements for use.
- ☐ Copy Handout 7-1.
- ☐ Gather supplies.
- ☐ Copy and cut up slips of food items (Handout 7-2) for learners to graph.

On-line. The Food Finder at http://www.olen.com/food/ has fast food information for 19 fast food chains. You can use the finder to locate information about total calories, fat, calories from fat, cholesterol, sodium, carbohydrates, proteins, fiber, and sugars in more than 1,000 fast food items.

Fast Food Facts at http://dfwmusic.com/fastfood/completeraw.html has data on portion weight, calories, fat grams, calories from fat, and percentage of calories from fat for many popular food items at more than 20 restaurant chains.

The Center for Science in the Public Interest at http://www.cspinet.org has lots of data on the nutritional content of fast foods.

By e-mail. To order the free pamphlet *Fast Food Facts* from the Minnesota Attorney General's office, send an e-mail with your name and address to consumer.ag@state.mn.us.

By mail. The brochure *Fast Food: Today's Guide to Healthy Choices* is available from the National Dairy Council, Item 0135N. The council is headquartered in Rosemont, IL 60018-5616. Materials may also be ordered from regional dairy councils.

In person. Most fast food chains have nutritional brochures available at their restaurants. Make sure to ask in advance in case they need to order them for you.

When graphs are completed, ask learners what they have discovered. Many will be surprised at the fat and sodium content of the foods they eat regularly. Point out that graphing is a useful tool for making many kinds of comparisons.

Activity 8

Nutrition Detectives

Leader Notes

This activity investigates nutritional values by using food labels. Working in teams, learners read labels from a variety of packages. They compare nutrients in similar foods. Directions for the activity are found in Handout 8-1.

Key Questions

- What can labels tell me about the nutritional value of a food?
- How can I use label information to choose what I will eat?

Before this activity, you will need to collect a lot of food labels. Determine the categories of food you want learners to analyze. We suggest the following: lunch meat, chips, candy, cereal, and canned soup. You may want to use others as well. Just make sure you have a variety of foods within each category. Use foods that are popular among young people in your area. Parents and learners can help with label collection.

Organize labels into stations. For example, one station will consist of soup labels, another of candy labels. Teams will rotate among the various stations.

Divide learners into equal teams of two to five members. Assist learners in decoding the first label. Then give them time to practice. Point out that not all foods contain all nutrients. Note that not all labels contain all information.

Distribute Handout 8-2.

Tell learners that if a particular food item contains none of the nutrients in question, they should put "NA" on their handout. Because they are nutrition detectives, they will need to read labels carefully to make sure they aren't missing anything.

Materials Checklist

- ☐ Directions (Handout 8-1) (1 set per team)
- ☐ Label sheet (Handout 8-2) (1 per team)
- ☐ Pencils (1-2 per team)
- ☐ Labels. You will need at least 5 labels for each category of food. If you are using the suggested categories, you will need these:
  - 5 different cereal boxes
  - 5 different soups
  - 5 different candy wrappers
  - 5 different chip bags
  - 5 different lunch meat wrappers

Approximate Time Required

30 minutes

Environmental Note

Recycle leftover paper.

What to Do in Advance

- ☐ Collect food labels.
- ☐ Copy handouts.
- ☐ Set up food in stations.

Answers to the activity questions will vary depending on which foods are used. You will need to prepare an answer sheet in advance. Use information from the labels you will use in the activity.

When the teams have completed their rotations, bring learners together to review their answers. Answers to the question "Which food is the most nutritional choice?" will vary. As teams discuss the reasoning behind their choices, a productive discussion will take place.

Activity 9

Recipes for Health

Leader Notes

In this activity, learners will put together foods and spices to produce tasty, nutritious dishes. They will use a variety of cookbooks and find recipes on the Internet and in newspapers. They will select nutritious recipes they would like to make and study the recipes for unfamiliar ingredients. They will make charts connecting foods and places. They will compare their collections to the food pyramid.

Key Questions

- Why are particular foods and spices popular in particular parts of the world?
- What are some practical, religious, historic, and social reasons that ethnic and regional cuisines developed?

Prompt learners to explore recipes from a variety of cuisines. Keep them focused on nutrition. Don't let them focus only on what they think will taste good—fried foods and desserts! Encourage them to bring favorite recipes from home and from relatives. Have cookbooks from different cuisines available (for example, Greek, Ethiopian, Chinese, soul food, Appalachian, Creole, German, Southwestern, French, Southern, Swedish, Polish, Italian, or Mexican). If you are working with a small group of learners, you may wish to do this activity in a local library in order to have a variety of books and an Internet connection available.

Handout 9-1 has directions for analysis. Ask learners to look through the cookbooks. Have them list unfamiliar ingredients that appear frequently in the recipes. Their lists should contain foods and spices common in the recipes but which they have not seen or tasted. They may mention mole, cassava, grape leaves, quinoa, cactus, couscous, mangos, varieties of peppers, and various seafoods—a world of foods.

Materials Checklist

☐ Directions (Handout 9-1) (1 per learner or station)

☐ Various recipe books or recipes from newspapers or magazines (and/or Internet access)

☐ Index cards (2-3 per learner)

☐ Pencils (1 per learner)

☐ Envelopes or Ziploc® bags to hold finished recipes (1 per learner)

☐ Stickers (optional)

☐ Chart paper (2 sheets plus an extra per learner or team)

☐ Chart markers (3-4)

☐ Materials to make recipe book (optional) (materials will vary)

Approximate Time Required

Time varies widely depending on depth of research and whether or not learners make their own recipe books.

Environmental Note

Reuse or recycle any leftover paper.

What to Do in Advance

☐ Gather materials.

☐ Arrange for access to recipe and research sources (books, Internet, magazines, etc.).

Learners should select a recipe that sounds enticing. They should copy it on a card then decorate the card. Ask them to select the main ingredient in the recipe. Have them classify each *ingredient according to the food pyramid scheme (i.e., grains,* vegetables, fruits, meats, beans).

Learners should pool their data. They can create a chart listing cuisines and ingredients. When the chart is complete, ask them to speculate about why certain ingredients are popular in a particular region's cuisine. Responses should consider geography and climate. For example, in remote rural areas of Appalachia, bananas are not a traditional food. They can't be grown locally. Until recently, it was hard to transport such a perishable food. However, the pawpaw, a tasty fruit that grows wild in the region, is popular in puddings and other foods. Poke, a wild herb, is a popular salad green. Because wild deer are plentiful in the region, sausage may be made with deer meat as well as with pork. History and religion may also be important factors. In many Middle Eastern cuisines, lamb is widely used, but pork is forbidden. In other regions, diets may be entirely vegetarian. Food preservation is another critical concern. For example, food is often spicier in hot places than it is in cooler climates. People have wondered about this for years. One popular suggestion was that eating spicy foods can cause people to sweat and cool down. This is useful in a warm climate. But we now know that many of the same spices that make food "hot" actually help preserve food. This is important in warmer climates, where foods spoil faster than in cooler climates.

Learners should also record these data on a second chart. They can tally the number of recipes that have as a main ingredient each of the different food groups on the pyramid (vegetables, fruits, grains, etc.). Are there any food groups left out of your collection?

If you have an Internet connection, you may wish to use electronic sources for the recipes. These can replace cookbooks or be additions to them. If you use electronic sources, learners can print out their recipes and paste them on cards instead of copying by hand.

You may want to put together a book of recipes popular with young people. Include nutritional information for each recipe. You might organize them by the food group of the main ingredient (grains, fruits, etc.). Make sure you are using family recipes. Do not use someone else's copyrighted materials in the book.

If you are in a classroom, you may wish to have students make reports on the history of various foods and spices. This activity integrates history, science, language arts, and geography.

CAUTION

Safety Notes

1. If you use the Internet for recipes or research, get permission from parents (in writing). Be sure to monitor Internet use. Do not let learners go to sites that are off-task.
2. If you are accessing the Internet in school, make sure that you follow all policies on student Internet use.

Activity 10

It Couldn't Happen Here! Diet, Health, and My Community

Leader Notes

Many major community health problems involve nutrition, among other factors. Heart disease, atherosclerosis, osteoporosis, cancer, diabetes, obesity, anorexia, bulimia, and anemia can all be linked to nutrition. This is an open-ended research activity. Learners will explore the impact of nutrition-related diseases on their community. They can then share what they have learned with the community.

Research can take several forms. First, learners should uncover the major health problems in their community. Public health services, nutritionists, and physicians are all good sources of information. Learners should talk to some of these professionals and read their writings. Many communities publish this data on the Internet.

Once learners discover the major problems, they should find out which may be nutrition related. Then they may use Geographic Information Systems to map the data on nutrition-related illnesses. They can look for higher than normal instance of these illnesses and see if there are connections between communities and these illnesses. Or, they may want to interview community residents to ask them about the foods they eat. They may want to work with other students. They can have their peers keep food logs then analyze them for nutrition information. Doing this, learners may be able to pinpoint key areas to work on.

Learners should identify key areas where they think changes could be made. Then they should develop ways of telling the community about their suggestions. They can do this in newspaper articles; a community health fair; exhibitions at local

Materials Checklist

- ☐ Access to data on community health issues (via the library, Internet, public health service, etc.)
- ☐ Other materials vary depending upon type of research and exhibition

Approximate Time Required

Varies—1 week to 1 month

Environmental Note

Reuse or recycle any leftover paper.

What to Do in Advance

- ☐ Arrange meeting with public health officials, doctor, or nutritionist (optional).
- ☐ Arrange access for data collection (Internet, interviews, library, etc.).
- ☐ Decide how much time to set aside for research and development and how in-depth activities can be in the time allotted.

community centers, shopping areas, or places of worship; television and radio public service announcements; flyers and books about healthier versions of foods popular in the area; or other events or publications. In these events or publications, learners should know that creativity will get them more attention. They could use multimedia presentations, posters, skits, tasting booths, or other activities.

Materials Summary

Activity 1

☐ 3-D food pyramid directions (Handout 1-1) (optional—1 copy per learner)
☐ 3-D food pyramid (Handouts 1-2 and 1-3) (1 set per learner, copied on card stock or heavy paper)
☐ Colored pencils or markers (1 set for every 4 learners)
☐ Scissors (1 pair for every 4 learners)
☐ Glue or rubber cement (1 bottle for every 4 learners)
☐ Tape (1 roll for every 4 learners)
☐ Handouts 1-5 and 1-6 (1 copy per learner)
☐ Copies of Handouts 1-7 and 1-8 (1 copy for every 8 learners)

Activity 2

☐ Directions (Handout 2-1) (1 per learner)

- Apple Smiles

☐ Red apples (1 apple per 8 learners)
☐ Peanut butter (1 teaspoon per learner)
☐ Miniature marshmallows (3 per learner)
☐ Paring knife (1 per 8 learners)
☐ Table knife (1 per 8 learners)
☐ Paper towel (at least 1 per learner)

- Gorp

☐ Dry measuring cup (1/4 cup) (1)
☐ Ziploc® bag (1 per learner)
☐ Peanuts (1/4 cup per learner)
☐ Raisins (1/4 cup per learner)
☐ Sunflower seeds (1/8 cup per learner)

- Ants on a Log

☐ Celery (1 stalk per two learners)
☐ Peanut butter (1 tablespoon per learner)
☐ Raisins (8-10 per learner)
☐ Clean rags (1 per learner)

Activity 3

- Orange Soda

☐ Directions (Handout 3-1) (1 per learner)
☐ Recipe (Handout 3-2) (1 per learner)
☐ Club soda (4 oz. [1/2 cup] per learner)
☐ Teaspoon—to measure sugar (1 per 8 learners)
☐ Spoon to measure orange extract (1/4-teaspoon size) (1 per 8 learners)
☐ Sugar (4 teaspoons per learner)
☐ Orange extract (1/4 teaspoon per learner)
☐ Red food coloring (1 drop per learner)
☐ Yellow food coloring (2 drops per learner)
☐ Measuring cup (cup size) (1 per 8 learners)
☐ Drinking cups (1 per learner)
☐ Spoons for stirring (1 per learner)

- Testing for Starches

☐ Directions (Handout 3-3) (1 per learner)
☐ Data chart (Handout 3-4) (1 per learner)
☐ Tincture of iodine (1 bottle) Note: Tincture of iodine is available in most drugstores and in the pharmacy section of supermarkets.
☐ Dropper (1 per 8 learners)
☐ Paper cup or other container to hold diluted iodine solution (1 per 8 learners)
☐ Water (to dilute iodine)
☐ Small samples of various foods to test (suggested foods include breads, potatoes, cornstarch, crackers, rice, vegetables, fruits, candy, sugar, dried beans, yams, honey, green banana, ripe banana) Note: Make sure to pick foods that are relatively light in color. If the food item is too dark, color changes will not be obvious.
☐ Paper towels, paper plates, or napkins to hold food samples (1 per food item used)

- Testing for Vitamin C

☐ Directions for vitamin C test (Handout 3-5) (1 per learner)
☐ Tincture of iodine (1 bottle—you can use the same bottle that you used in the starch test)

☐ Scurvy preventer chart (Handout 3-6) (1 per learner)

☐ Dropper (1 for each food item)

☐ Cornstarch solution (1 teaspoon cornstarch dissolved in 1 cup boiling water per 8 learners)

☐ Samples of various nutrients and food juices to test (suggested foods include lemon juice, orange juice, commercial juice drinks, other fruit and vegetable juices, vitamin C tablets, sodas)

☐ Small glasses, paper cups, or test tubes to hold liquids (1 per food item used)

Activity 4

- Fats test

☐ Directions (Handout 4-1) (1 per team)

☐ Brown paper bag (may be cut into squares) (1 per team)

☐ Variety of foods (enough for each team to have a small sample) Suggestions: potato chips, carrots, apples, nuts, bacon, biscuits, other baked goods. Ask learners to bring some of their own items to test.

- Fishbowl

☐ Directions (Handout 4-2) (1 per team)

☐ Various articles on olestra (including those representing the industry's point of view and those critical of olestra)

Note: Newspapers, magazines, and the World Wide Web provide information that may be useful.

Activity 5A

Materials will vary depending on the setup you use and how many foods learners test. This is a sample list:

☐ large sewing needles, craft pins, long nails or metal skewers (1 per learner or team), cork, chunk of clay, thick slice of potato or some other substance to serve as a base to hold the needle or nail (1 per learner or team)

- Samples of foods to test:

☐ Peanuts, popped popcorn, many snack foods, and various nuts—foods with high oil and low water content work well (also try miniature marshmallows) (3-4 small samples per learner or team)

☐ Containers for heating water: a beaker, Pyrex® measuring cup, baby food container, or small sturdy glass jar (1 per learner or team)

☐ Materials for suspending water container above flame

☐ Matches, lighter, Bunsen burner, or other method for setting the food on fire

☐ Thermometers (optional, 1 per learner)

☐ Handout 5-1A (1 per learner)

Activity 5B

Materials will vary depending on the setup you use and how many trials learners do. This is a sample list:

☐ Large sewing needles, craft pins, long nails or metal skewers (1 per learner or team), and cork, chunk of clay, thick slice of potato, or some other substance to serve as a base to hold the needle or nail (1 per learner or team)

- Samples of foods to test:

☐ Peanuts, popped popcorn, many snack foods, and various nuts—foods with high oil and low water content work well (also try miniature marshmallows) (3-4 small samples per learner or team)

☐ Containers for heating water: a beaker, Pyrex® measuring cup, baby food container, or small sturdy glass jar (1 per learner or team)

☐ Materials for suspending water container above flame

☐ Matches, lighter, Bunsen burner, or other method for setting food on fire

☐ Thermometers (1 per learner or team)

☐ Balance for weighing food and water

☐ Calculators (1 per three learners or teams)

☐ Pencils (1 per learner or team)

☐ Handout 5-1B (1 per learner)

☐ Handout 5-2B (1 per team per set of trials)

Activity 6

☐ Directions (Handout 6-1) (1 copy per learner)

☐ Work sheet (Handout 6-2) (1 copy per learner)

☐ Pencils (1 per learner)

☐ Calculators (1 per 2 learners)

☐ Calorie charts (1 per 2 learners)

Activity 7

- ☐ Directions (Handout 7-1) (1 per learner)
- ☐ Markers of several colors (1 set per 8 learners)
- ☐ Yardsticks (1 per 4 learners)
- ☐ Easel paper (3 sheets per team, plus extras)
- ☐ Tape (1 roll)
- ☐ Nutritional information on various fast foods (1 copy per learner)
- ☐ Table to record nutritional information (1 copy per team) (Handout 7-2)
- ☐ Food item slip (1 slip per learner copied from Handout 7-3)

Activity 8

- ☐ Directions (Handout 8-1) (1 set per team)
- ☐ Label sheet (Handout 8-2) (1 per team)
- ☐ Pencils (1-2 per team)
- ☐ Labels. You will need at least 5 labels for each category of food. If you are using the suggested categories, you will need these:
  - 5 different cereal boxes
  - 5 different soups
  - 5 different candy wrappers
  - 5 different chip bags
  - 5 different lunch meat wrappers

Activity 9

- ☐ Directions (Handout 9-1) (1 per learner or station)
- ☐ Various recipe books or recipes from newspapers or magazines (and/or Internet access)
- ☐ Index cards (2-3 per learner)
- ☐ Pencils (1 per learner)
- ☐ Envelopes or Ziploc® bags to hold finished recipes (1 per learner)
- ☐ Stickers (optional)
- ☐ Chart paper (2 sheets plus an extra per learner or team)
- ☐ Chart markers (3-4)
- ☐ Materials to make recipe book (optional) (materials will vary)

Activity 10

- ☐ Access to data on community health issues (via the library, Internet, public health service, etc.)
- ☐ Other materials vary depending upon type of research and exhibition

Handout 1-1

Building and Using the Pyramid

Directions

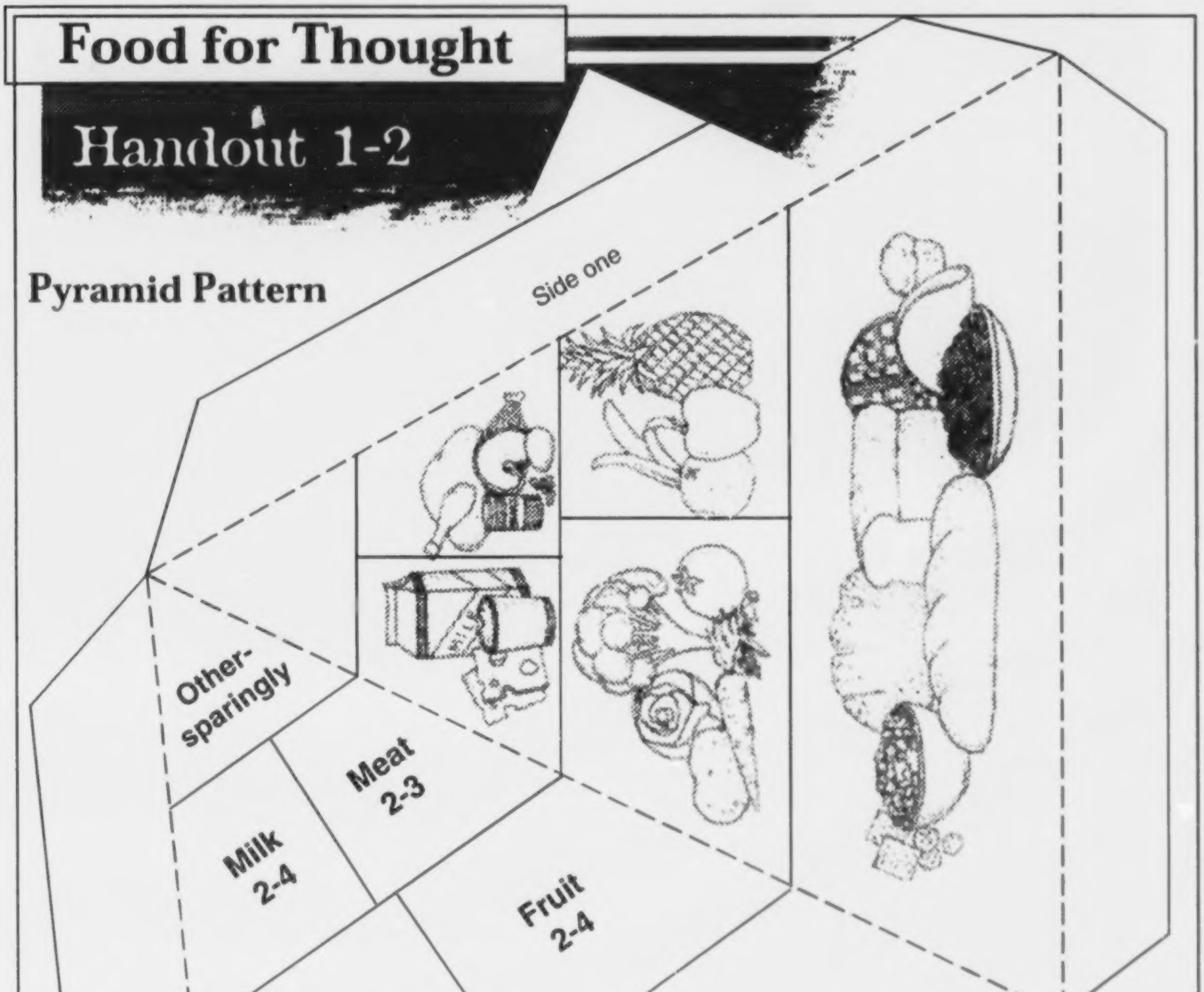
You should have copies of Handouts 1-2 and 1-3 (the sides of the pyramid). Color all sides of the pyramid. Cut out the pyramid sides along the outer edge and fold on the dotted lines. Then glue the folded tabs together.

Put your name on your pyramid. Keep it handy to use as a reference throughout the rest of this project.

Food for Thought

Handout 1-2

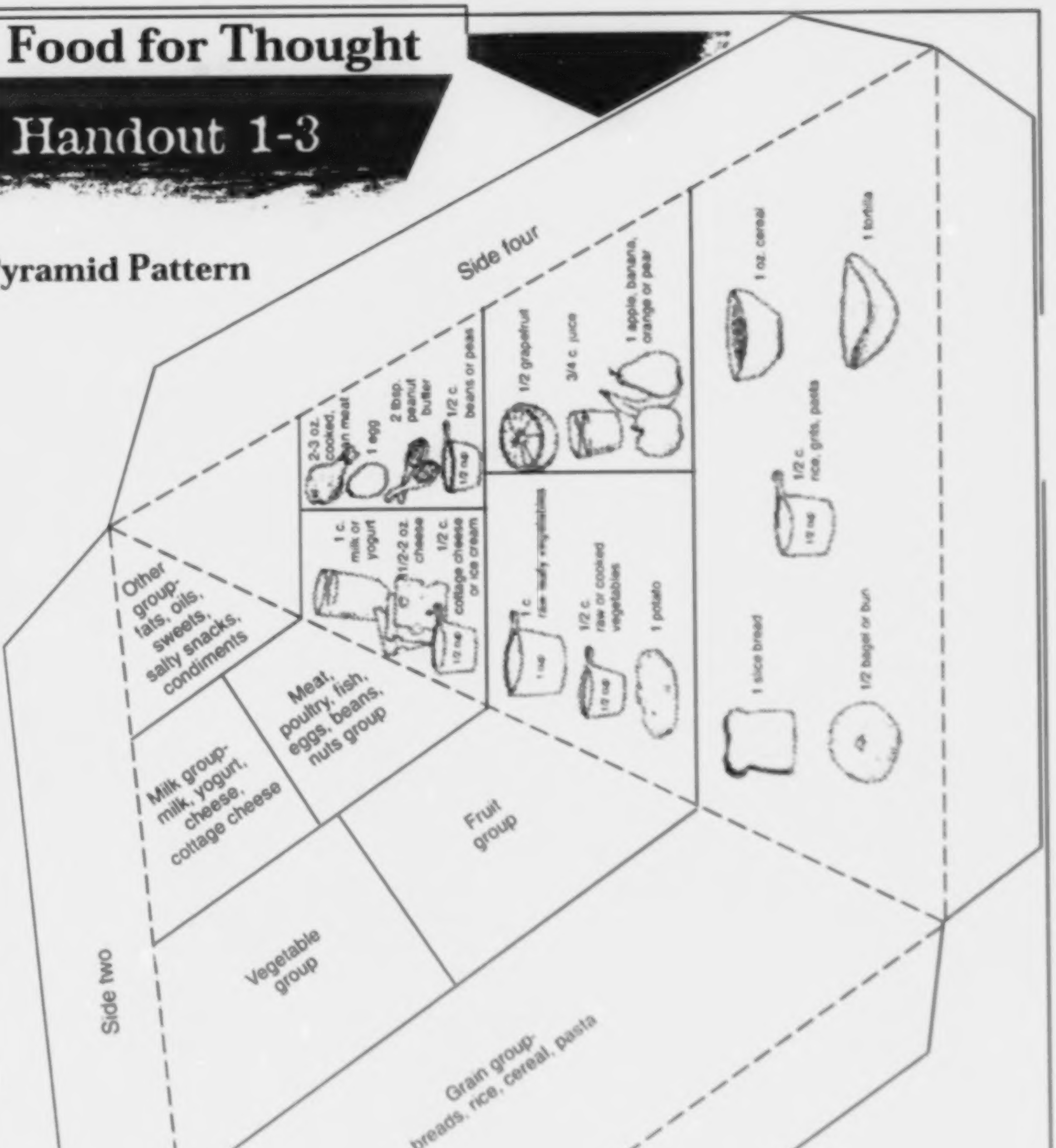
Pyramid Pattern


Side one
Other-
sparingly
Meat
2-3
Milk
2-4
Fruit
2-4
Vegetable
3-5
Grain
6-11
Side three

Food for Thought

Handout 1-3

Pyramid Pattern


Side four
Side two
Other group- fats, oils, sweets, salty snacks, condiments
Meat, poultry, fish, eggs, beans, nuts group
Milk group- milk, yogurt, cheese, cottage cheese
Fruit group
Vegetable group
Grain group- breads, rice, cereal, pasta
2-3 oz. cooked, lean meat
1 egg
2 tbsp. peanut butter
1/2 c. beans or peas
1 c. milk or yogurt
1 1/2-2 oz. cheese
1/2 c. cottage cheese or ice cream
1/2 grapefruit
3/4 c. juice
1 apple, banana, orange or pear
1 c. raw leafy vegetables
1/2 c. raw or cooked vegetables
1 potato
1 oz. cereal
1 tortilla
1/2 c. rice, grits, pasta
1 slice bread
1/2 bagel or bun

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Handout 1-4

Food Log

Name ______________________________

Every day for a week, put a tally mark down for each serving you eat. Check your tally against the values recommended on your pyramid daily and at the end of the week.

	Grain	Fruit	Vegetable	Meat	Milk	Other
Day 1						
Day 2						
Day 3						
Day 4						
Day 5						
Day 6						
Day 7						

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The Real Foods Challenge

Much of the food you eat consists of combinations of other food groups. A chef salad may contain vegetables, meat, cheese, croutons, and oil. These foods come from the vegetable, meat, milk, grain, and "other" parts of the pyramid. A serving of lasagne generally contains pasta (grain), vegetables (tomatoes and often mushrooms, carrots, etc.), cheese, meat, and other foods. Keep track of your "pyramid progress" through your food log. You will need to look at what makes up the combination foods you eat.

Try this activity to see if you know what goes into your food—and how to count servings on the pyramid.

Directions

Draw one breakfast item from the Breakfast Bowl and one lunch item from the Lunch Box. Estimate how many servings you have from each section of the food pyramid, and tally your estimates on the "Breakfast and Lunch" rows on the Real Foods Chart (Handout 1-6).

Next, compare the number of servings you estimated for each food group with the number of servings suggested by the pyramid. Count how many more servings from each group you should eat before the end of the day. See if you can plan a menu for dinner and snacks that will provide you with proper nutrition for the day.

Handout 1-6

Real Foods Chart

NUMBER OF SERVINGS

	Grain	Vegetable	Fruit	Meat/Beans	Milk/Yogurt	Other
Breakfast (from bowl)						
Lunch (from box)						
Dinner						
Snack						

Dinner menu:

____

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____

Snack menu:

____

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Food for Thought

Handout 1-7

Breakfast Bowl Items

Cheese and mushroom omelet: 2 eggs, 2 slices cheese, mushrooms, butter, and a small glass of orange juice

Big bowl of cereal (3 oz.) with milk and banana

Yogurt (1 cup), an English muffin with jelly, and a large glass of orange juice

Leftover sausage-and-mushroom pizza (1/4 of a medium 12-inch pizza), can of V8®

2 large biscuits, 1 slice ham, 2 eggs, 1 slice cheese, coffee, jelly, butter

You skipped breakfast

3 medium buttermilk pancakes, syrup, butter, 3 slices bacon

Apple, small bowl of oatmeal, toast with butter and jelly

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Food for Thought

Handout 1-8

Lunch Box Items

Leftover sausage-and-mushroom pizza (1/4 of a medium 12-inch pizza), can of V8®

Large 2-cup Greek salad (lettuce, olives, 1 tomato, 1 egg, 1/4 onion, 1 loaf pita bread, feta cheese, olive oil, vinegar)

Foot-long ham-and-cheese sub with mayonnaise, small bag of chips

Plate of pasta with meat sauce and cheese, garlic cheese bread

Taco salad with edible bowl, guacamole, sour cream, cheese

Bean burrito, cheese enchilada

Fried chicken, 2 biscuits, 1 slice of apple pie

You skipped lunch

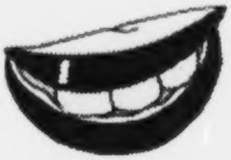
Large bowl of chili with beans (1-3/4 cups), 8 crackers, glass of milk

Quarter-pound hamburger with lettuce, tomato, mayonnaise, bun, large order fries, large soda

Fired chicken nuggets, sauce, potato salad (potatoes, mayonnaise, pickle relish), biscuit

Handout 2-1

Ants on a Log? Yummy!



Apple Smiles

Equipment: Paring knife, table knife

Ingredients: Red apples, peanut butter, miniature marshmallows

Instructions:

1. Wash apples and remove core.
2. Slice into 16 pieces.
3. Spread one side of each slice with peanut butter.
4. Place 3 marshmallows on top of the peanut butter on one side.
5. Top with another apple slice, peanut butter side down. Press together.

Makes 8 "smiles."

GORP

Equipment: 1 dry measuring cup (1/4 cup), Ziploc® bags (1/learner)

Ingredients: Peanuts, raisins, sunflower seeds

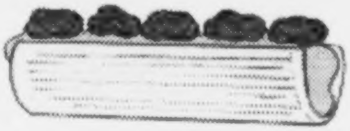
Instructions: Put 1/4 cup of peanuts and 1/4 cup of raisins in a Ziploc® bag. Sprinkle in a few sunflower seeds. Close bag and shake to mix.

"Ants on a Log" Recipe

Equipment: Table knife

Ingredients: Celery, peanut butter, raisins

Instructions: Clean celery and cut into 4-inch sections. Fill with peanut butter. Line up raisins across the peanut butter to represent the ants on the celery log.



Handout 3-1

How Much Sugar Is in My Soda?

Directions

Read through the recipe (Handout 3-2) so that you are familiar with it. Then make the orange soda according to the directions.

Enjoy drinking your creation!

You have just enjoyed drinking 4 ounces of orange soda that contained 4 teaspoons of sugar. Based on the recipe you just used, figure out how much sugar would be in a 12-ounce can of soda. Be sure to show your calculations and explain your thinking!

I drink an average of ____________________ soda(s) a day. This means I consume an average of ________________________ teaspoons of sugar from soda each day.

Clean up your area. If you didn't drink all your soda, dispose of it properly.

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Food for Thought

Handout 3-2

Orange Soda Recipe

4 ounces of club soda (1/2 cup)
4 teaspoons of sugar
1 drop of red food coloring
1/4 teaspoon of orange extract
2 drops of yellow food coloring

Combine all ingredients and stir gently. Drink and enjoy

Food for Thought

Handout 3-3

Testing for Starches

Directions

Carbohydrates are present in many foods, including vegetables and grains. *Sugars*, starch, and cellulose are familiar examples of carbohydrates. *Glucose*, fructose, and sucrose are the names of three simple sugars. Starch and cellulose are large, complex molecules made up of many units of glucose. Starches are made by plants as a way of storing sugar for energy needs. They provide the main source of energy for our bodies.

You can test whether starch is present in a food by using *iodine*. (The iodine you are most likely to be familiar with is a reddish brown *tincture*—a solution of iodine dissolved in alcohol. It is one of the most effective *disinfectants* available.) When iodine and starch combine, the iodine stains the starch a deep blue.

Your leader has prepared a variety of foods for you to test. Before beginning, fill in the Starch Test table (Handout 3-4) with the names of the foods that you will be testing. Then, predict whether the food will contain starch. After you have made your predictions, test a small amount of each food and record your results.

Definitions

Carbohydrates are molecules composed of carbon, hydrogen, and oxygen. Carbohydrates are a major class of foods. Most carbohydrates are made by plants.

Sugars are small, fairly simple carbohydrates that usually taste sweet.

Glucose is a sweet, colorless sugar with the formula $C_6H_{12}O_6$. It is the most common form of sugar used as energy in the bodies of animals (including humans).

Iodine is a chemical element used in medicine, photography, and other areas. A **tincture of iodine** is a solution made by dissolving iodine crystals in alcohol. It can be used to disinfect small wounds and to test for starch and vitamin C.

A **disinfectant** is a substance that destroys or slows the growth of some forms of harmful microorganisms.

The Testing Procedure

Fill the empty cup halfway with water. Add one or two drops of iodine and swirl the liquid mix. Your iodine solution should be a deep yellow color. If it is not dark enough, add another drop of iodine. If the solution in your cup is too dark, add more water until you get a deep yellow color.

Take a small amount of each food that you are to test. Using the dropper, put a drop of the diluted iodine solution on the food. If the solution turns deep blue, the food contains starch.

Record your results. Are any of the results surprising? Do you think that cooking the food would change the results? Why or why not?

CAUTION

Safety Note

Iodine is useful as a disinfectant because it kills many organisms. **It is poisonous to humans!** Do not taste the iodine or eat any food after it has been tested with iodine. Make sure that you dispose of your leftover iodine solutions and tested food so that younger children or pets cannot get access to them.

Food for Thought

Handout 3-4

Starch Test

Data Chart

Food item	Prediction: Will it contain starch? (Y/N)	Results: Did it contain starch? (Y/N)

Food for Thought

Handout 3-5

Testing for Vitamin C

Directions

Vitamins are compounds that are necessary in very small amounts to maintain good health. Vitamins must be included in your diet since the body usually does not produce them. About a dozen vitamins have been identified. Some vitamins can be stored in body fat; others cannot. Vitamin C is one of the best known vitamins. It cannot be stored in the body, so it must be a part of the daily diet. Citrus fruits, such as oranges, grapefruit, and lemons, as well as tomatoes, green peppers, and a few other vegetables, have lots of vitamin C in them. Sometimes we may take the availability of vitamin C for granted. After all, we have easy access to citrus fruits, but lack of vitamin C has had an impact on the course of history.

A disease called scurvy was common until the 1900s, particularly among sailors but also among the general population. Scurvy, caused by a lack of vitamin C, has symptoms such as loss of appetite, bleeding gums, loose teeth, swollen ankles, and tiny hemorrhages (bleeding spots) in the skin. Scurvy killed 2 million sailors in the years 1500-1800, which is as many as were lost in battles or shipwrecks. One journey in the 1740s lost almost 90 percent of its crew to scurvy. Sailors were especially at risk of getting scurvy because they had to live for long periods of time on cured foods, which contain little vitamin C. Even Robert Scott's expedition to the South Pole in 1901 was hit hard by scurvy. If it were not for the effects of scurvy, sea-going nations in the 1500s to 1800s might have controlled a far larger portion of the globe than they did. It was not until scientists discovered the role of vitamin C in 1928 that scurvy ceased to be a major concern.[1]

Now that scientists know about vitamin C, we can test for it in foods. An easy test for vitamin C is based on the iodine test you did for starches. Vitamin C reacts with iodine, using the iodine up. So, if starch and iodine are combined and a food containing vitamin C is added, the vitamin C uses up the iodine, and the blue-black color of the starch-iodine combination disappears.

Your leader has prepared a variety of foods for you to test. Before beginning, fill in the Scurvy Preventers table (Handout 3-6) with the names of the foods that you will be

CAUTION

SAFETY NOTE

Iodine is poisonous if eaten or swallowed. Do not do the starch and vitamin C tests with young children who might ingest the iodine. Do not leave the iodine where a young child can get access to it.

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testing. Then, predict whether each food will contain vitamin C. After you have made your predictions, test a small amount of each food and record your results. The foods that contain vitamin C could be scurvy preventers.

The Testing Procedure

Put about 20 drops of the starch solution in a cup of water. Add one or two drops of iodine. (The water should turn slightly blue.) Add food to the water. If blue disappears, the food contains vitamin C.

Food for Thought

Handout 3-6

Scurvy Preventers

Food	Prediction: Do I think this food can help prevent scurvy? (Y/N)	Can this food be a scurvy preventer? (Y/N)

Food for Thought

Handout 4-1

Testing for Fats–It's in the Bag!

Directions

Brown paper bags are useful tools for testing whether foods contain fats.

For each of the foods provided, predict whether or not the food will contain fats. Record your prediction in the table.

Test your knowledge. Cut a square out of the bag for each food item that you want to test. Label the squares with the names of the food items. Rub the food onto the square until there is a wet spot. Set the squares aside to dry.

If a greasy spot remains after the square dries, the food contains fat. Record your findings in the table, next to your predictions. How good were you at predicting fats in foods?

Food	Fat predicted (yes/no)	Contains fat (yes/no)
potato chips		
carrots		
apples		
nuts		
bacon		
biscuits		
food:		
food:		
food:		
food:		
food:		

Food for Thought

Handout 4-2

A Fishbowl on Olestra

Directions

You and your teammates will be exploring controversies about the nondigestible fat olestra, which is used in many snack foods. You will do this in a "fishbowl" format.

A fishbowl is an activity where only part of the group gets to talk at one time. The rest of the group sits in a circle surrounding the people in the fishbowl. Only people inside the fishbowl are allowed to talk. People outside the fishbowl must sit silently, and listen. Later, the listeners get a chance to be in the fishbowl and those who were in the fishbowl get a chance to listen. In your fishbowl, you will discuss this question:

Should we buy snacks containing olestra for our ___________ (class, troop, club, group)?

Some of you will be in favor of buying the olestra-containing snacks. Others will be against buying olestra-containing products. You will do some research on the debate for and against using olestra. You will bring your information together in the fishbowl discussion. You should be prepared to present both sides of the question and to back up your opinions with evidence.

Prepare your case carefully. You will need to explore information about the health effects—positive and negative—of using olestra, then bring this information together to produce a presentation or theory that will convince others that they should follow your advice.

Here are some places to begin your research:

- The Center for Science in the Public Interest (a consumer group that opposes olestra)
- Frito-Lay and Proctor & Gamble (companies that sell olestra-containing products)
- The Harvard Olestra Project (a major research study on olestra)

Newspapers, popular magazines, health-related magazines, and the World Wide Web are good sources for information on olestra. Just make sure you critically examine the information you find!

Food for Thought

Handout 5-1A

Help! I'm Burning My Food! Calories in Common Foods

Directions

What is this thing called a calorie? How does a measure of heat relate to food? Find out by exploring the calorie content of several common foods. You will burn food to heat water. From the change in water temperature and the amount of food burned, you can get a sense of the relative calorie content of different foods.

The energy in foods is stored chemical energy. Energy is converted to a usable form by breaking one set of chemical bonds and forming new bonds, which release energy in the process of forming. Our bodies release this energy slowly through a series of chemical reactions.

We define the energy in food in terms of heat because we determine calorie values by measuring the heat given off when we burn food. The more calories a food contains, the more heat it will produce when burned.

Your leader will show you the setup you will use and will provide test food items. Be careful with flames and with hot equipment!

Use a thermometer or your fingers to get a feel for how much the water was heated by burning the food. (Be careful and don't burn your fingers!!!) The food would create just as much heat in your body if you had eaten it!

Procedure

Put your food sample on the end of the pin or nail. Put the other end of the pin or nail in the material that you are using as a holder.

Set the food on fire. It may take several tries to get the food lit. Immediately move the burning food sample under the container of water.

After the sample has finished burning, notice the difference in temperature of the water you just heated. The temperature went up because of the heat given off by the burning food.

Try the activity with other samples of food. Make sure to use new water each time. Do you notice any relationships between the types of foods you are burning and the changes in temperature? Between the types of food and length of time they burn?

Would this method work for all foods? Why or why not? What might you have to change to make it work for other foods?

Were any of the results surprising? Why or why not?

Handout 5-1B

Help! I'm Burning My Food! Measuring Calories in Common Foods

Directions

What is this thing called a calorie? How does a measure of heat relate to food? Find out by determining the calorie content of several common foods. You will burn food to heat water. From the change in water temperature and the amount of food burned, you can calculate an approximate calorie content for the foods.

The energy in foods is stored chemical energy. Energy is converted from storage to a usable form by breaking one set of chemical bonds and forming new bonds, which release energy in the process of forming. Our bodies release this energy slowly through a series of chemical reactions.

We define the energy in food in terms of heat because we determine calorie values by measuring the heat given off when we burn food. The more calories a food contains, the more heat it will produce when burned.

Your leader will show you the setup you will use and will provide test food items. You or your team will need to carefully weigh water and food samples and measure temperature. Use the data table (Handout 5-2B) to record your values. Make sure and take the best and most precise measurements you can on the equipment you use!

Procedure

Use the balance to measure the mass of your first food sample. Record the mass, in grams, in the data table.

Measure the mass of your empty, dry water container. Record this mass, in grams, in the data table.

Fill the container about half full of water. Dry off any water you spilled on the outside of the container. Measure and record the mass of the container and water in grams.

Put your food sample on the end of the pin or nail. Put the other end of the pin or nail in the material that you are using as a holder.

Measure and record the temperature of the water in your container in degrees Celsius.

Set the food on fire. It may take several tries to get the food lit. Immediately move the burning food sample under the container of water.

After the sample has finished burning, measure and record the temperature of the water. There will be ash remaining from the sample. Measure the mass of the ash, and record it in the data table.

Using the information on the data table sheet, calculate the number of calories per gram in the food you just burned.

Do two more trials, with other samples of the same food. Make sure to use new water each time and make new measurements of each quantity. Determine an average value of calories per gram of the food.

If you have time, determine the calorie value of other types of foods.

Food for Thought

Handout 5-2B

Data Table and Calculations

Type of food: ____________________

Data Table

	Sample #1	Sample #2	Sample #3
Initial mass of food sample (g)			
Mass of container (g)			
Mass of container and water (g)			
Mass of water (g)			
Initial temperature of water (degrees Celsius)			
Final temperature of water (degrees Celsius)			
Change in temperature (degrees Celsius)			
Final mass of food sample (weight of ash) (g)			
Mass of food sample actually burned (g)			
Energy value of food (cal/g)			
Energy value of food (Cal/g)			

Average energy value of food: ____________________

Calculations

The mass of food that was actually burned is the difference between the mass of food you started with and the mass that was left over after burning (the ash). Calculate this value, and record it in the table.

The mass of the water is the difference between the mass of the can and water combined, and the mass of the can. Record this difference in the table.

The change in temperature of the water is the difference between the initial and final temperatures of the water. Record this value in the table.

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A quantity called specific heat is used in this calculation. The specific heat of a substance is the amount of energy it takes to raise a gram of the substance by a temperature of 1 degree Celsius. Different substances have different specific heats. The specific heat of water is 1 cal/g °C. This means that for every gram of water you are heating, it takes one calorie of energy to raise the temperature by one degree Celsius.

Using the data you collected and the specific heat of water, you can calculate the energy value of the food in calories per gram. (All your masses must be in grams and your temperatures must be in degrees Celsius!)

$$\text{Available energy (in calories/gram)} = \frac{\text{(mass of water) x (increase in temp.) x (specific heat of water)}}{\text{(mass of food sample burned)}}$$

For example, suppose you actually burned 4.7 grams of food. (That is, the difference between the mass of the food sample you ignited and the ash that remained was 4.7 grams.) Burning this much food heated up 567 grams of water. The temperature of the water went up by 22.8 degrees. Using this information, and the specific heat of water, you find that

$$\frac{\#\text{ calories}}{\text{g}} = \frac{(567\text{g}) \times (22.8°\text{C}) \times \left(\frac{1\text{ cal}}{\text{g °C}}\right)}{4.7\text{g}}$$

Notice that you have some of the same units in both the numerator (top) and the denominator (bottom) of the equation. If you cancel out like terms, you are left with units of calories/gram.

$$\frac{\#\text{ calories}}{\text{g}} = \frac{(567\cancel{\text{g}}) \times (22.8°\cancel{\text{C}}) \times \left(\frac{1\text{ cal}}{\cancel{\text{g}}\text{ °}\cancel{\text{C}}}\right)}{4.7\text{g}}$$

$$= 2750\text{ calories/g}$$

The common system of calorie measurement in America uses some very confusing language. The heat content of food, as found on food labels or on calorie charts, is actually measured in a unit that is 1000 times the size of the calorie value you just calculated. We often call food calories "large calories," "big calories," or "kilocalories." Its abbreviation (Cal) is designated with a capital C when written. The values you just calculated are called "little calories," "small calories," or just "calories" and are designated with a small c when written. To convert from calories to Cal, divide your calorie value by 1000.

Your sample would have 2.75 Cal per gram in available heat energy.

The difference between calories and Cal is tricky. Just remember that in the U.S., the heat content of food is generally reported in Cal. In countries that use the metric system and for scientific use, the units used are less easy to get mixed up. The heat content of food is reported in units of kilocalories. Your food sample has a heat value of 2.75 kcal/gram.

Calculate the available energy (in calories per gram) for your food samples, and record the values in the table.

Determine the number of Cal per gram in your food sample, and record these values in the table. Will the number of Cal per gram be larger or smaller than the number of calories per gram?

How do the calorie values you measured differ from those found in tables? Why do you think they are different?

What could you change in your experiment to get more accurate values?

Would this method work for determining the calorie content of all foods? Why or why not? What might you have to change to make it work for other foods?

Were any of the calorie values particularly surprising? Why or why not?

Food for Thought

Handout 6-1

How Many Calories Do You Need?

Directions

Work on your own on this activity. You want to determine a calorie level that is right for you.

Get a calorie work sheet, pencil, and calculator. Think carefully about how active you are, what your eating habits are, and what you ate yesterday.

Record the information on the work sheet, and calculate the approximate number of calories you need each day.

Look up information to determine the number of calories you consumed yesterday.

Evaluate your eating habits based on this prediction of your calorie needs and your activity level. Determine if you need to change your way of eating based on calorie consumption.

Food for Thought

Handout 6-2

How Many Calories Do You Need a Day?

An Exercise in Estimation and Approximation

1. Name ______________________________
2. Approximate weight ______________
3. How active are you? Circle A, B, or C.
   - A. I'm a couch potato. I get very little exercise per week.
   - B. I exercise moderately. This means I am active at least 30 minutes 3 times a week.
   - C. I exercise vigorously. This means I play a sport, jog, bicycle, or do some activity at least 5 days a week.
4. If you picked A, multiply your weight by 12. __________ x 12 = __________

   If you picked B, multiply your weight by 15. __________ x 15 = __________

   If you picked C, multiply your weight by 20. __________ x 20 = __________

   The number you just calculated is the approximate number of calories you need per day to maintain your current weight.
5. Use your food log to examine the list of foods you ate yesterday. Estimate the number of servings you had of each of the foods. Look up the food in the calorie charts provided and add up the number of calories you consumed yesterday. (Don't forget to include calories you drank, such as soda pop!)

Breakfast		**Lunch**		**Dinner**		**Snacks**	
Food	Calories	Food	Calories	Food	Calories	Food	Calories
			Totals				

Add All Four Totals ______ + ______ + ______ + ______ = ______

This total is the number of calories you ate yesterday.

6. How many calories did you calculate you need daily in question 4? ___________

7 How many calories did you eat yesterday? ___________

How does the number of calories you ate yesterday compare to the number of calories that you calculated you need? Are there any adjustments you think that you should make in what you eat or how much you exercise? If so, describe these

What other observations might you make from your food log that can help you protect your health?

Remember, consuming an appropriate number of calories does not mean you are eating a good diet. Be sure to eat the right foods (not just junk) so that the calories you take in supply you with all the nutrients you need.

Food for Thought

Handout 7-1

Comparing Fast Foods

Directions

Where is the healthiest fast food in town? Compare the nutritional content of a fast food item (hamburger, fries, etc.) as prepared at several different fast food restaurants by developing and interpreting a graph of either the fat, sodium, or calorie content of a food item.

Take a slip of paper from the envelope (only one please!) to see what food you will be graphing. Do not put it back in the envelope.

Compare fat, sodium, and calories for your item.

Examine your food guide (or Internet-based guide) for information about the item in a variety of different restaurants. Choose at least three restaurants to compare. Use the table in Handout 7-2 to record the values you will use on your graph.

Make bar graphs showing the information you found on your food item. For each of the three graphs, decide if you are counting by 5s, 10s, etc. The scales will change depending on your food and on the quantity you are comparing. Make sure that your scale is appropriate for showing differences in the nutritional levels of the foods you are using. Draw and shade your columns carefully.

Discuss what your graph says about the nutritional content of the food you graphed. Which restaurant would you choose if you were going to order that item?

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Food for Thought

Handout 7-2

Comparing Fast Foods Chart

Food item: ____________________

Restaurant	Fats	Sodium	Calories
1.			
2.			
3.			
4.			
5.			
6.			
7.			

Food for Thought

Handout 7-3

Food Items

Small hamburger	Chicken nuggets	Small cheeseburger
Large hamburger	Large cheeseburger	Small order of french fries

Handout 8-1

Nutrition Detectives

Directions

How do I find out which prepared foods are most nutritious? Take charge of your health—be a Nutrition Detective! This activity gives you a chance to practice your decoding skills and collar the most healthy foods.

Form teams of equal numbers or work in teams established by your leader. Make up a name for your team and put it on the Nutrition Detectives sheet.

As a team, you will search the food labels provided to find clues to answer the questions on the Nutrition Detectives sheet.

Your leader will have you start at a particular station. You will fill out one sheet for each station. When you have finished at one station, go on to the next. Continue rotating through the stations until you have been to all of them.

Not all foods will contain all nutrients. Not all labels will provide the same information. If a particular food doesn't contain the nutrient you are looking for, put NA on the answer sheet. But be careful! As a good detective, you'll need to examine the labels thoroughly to make sure you've found all the clues.

When you have all the information, work together to develop your case for which foods are the healthiest, and why. Can you defend your reasoning in front of a jury of your peers?

Food for Thought

Handout 8-2

Nutrition Detectives: Collecting Evidence from Food Labels

Group Name ______________________________

Category of food ________________________

Which item has the most fat? ____

Which item has the least fat? ____

Which item has the most sugar? ____

Which item has the least sugar? ____

Which item has the most sodium? ____

Which item has the least sodium? ____

Which item has the most calories? ____

Which item has the fewest calories? ____

Which item has the most dietary fiber? ____

Which item has the least dietary fiber? ____

Which item has the most protein? ____

Which item has the least protein? ______________________________

Which item contains the most fruits or vegetables?

____

Which item contains the smallest amount of fruits or vegetables?

____

Which item contains the most calcium? ______________________________

Which item contains the least calcium? ______________________________

For this category, which food is the healthiest choice? Why?

____

Food for Thought

Handout 9-1

Recipes for Health

Directions

Select a recipe book and leaf through it. Make a list of at least 5 or 6 unfamiliar ingredients—foods and spices you don't think you've ever seen or tasted but that seem common in the recipes you are reading.

Choose a recipe that sounds interesting and copy it to a card. Then decorate the card to reflect the recipe. Select the main ingredient in the recipe and figure out where it belongs in the food pyramid (i.e., grains, vegetables, fruits, meat/beans, etc.). Repeat the process with other ingredients. Be sure to put your name on the card in case it is misplaced.

Pool your data with those of other learners to create a chart listing cuisines and ingredients. When the chart is complete, speculate about why certain ingredients might be popular in the cuisine of a particular region.

Record your data on a second chart. Count the number of recipes your group has chosen that have as main ingredients each of the different groups on the pyramid (vegetables, fruits, grains, etc.). Are there any food groups left out of your recipe collection?

Put the finished card in a baggie to take home and cook up a storm—with permission, of course!!! Enjoy!

Food for Thought

Notes

1. Agricultural Research Service. *Vitamin C.*
2. Stradley. *Linda's Culinary Dictionary.*
3. *Things Japanese* and Torquay Elementary School. *Japanese Food.*
4. *Industry History.*
5. *ArabNet—Libya Culture: Food and Drink.*
6. "Subsistence of Slavery" and University of West Florida in Pensacola. "Foodways of the Original Americans."
7. Watson. "Poor Man's Meat."
8. "Egg Harvesting."
9. "Italian Staples."
10. "Fisherman's Cookbook."
11. "Blue Mackerel."
12. "Fisherman's Cookbook."
13. "Blue Mackerel."
14. Agricultural Research Service. *Vitamin C* and Carpenter. *History of Scurvy.*

Food for Thought

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Food Preservation

Crocked Cabbage, Jerked Beef, and Pickled Pigs' Feet

Introduction

In this project, young people learn about storing and preserving food. When they first hear about food preservation, they might think, "I live near a grocery store. I don't have a garden. I don't hunt. Why should I care about food preservation?" The activities can help answer this question.

They can also help young people appreciate the knowledge and skills their ancestors had. And they will see that technology is sometimes invented before people really understand what makes the technology work. For example, our ancestors probably didn't know all the scientific reasons that dried foods didn't spoil rapidly. But they found out that it worked and developed methods for drying foods. If people who lived before our time had not developed ways to store food, we would still be spending most of our time searching for food. We would not have much time to study science. We would be too busy finding our next meal!

In fact, humans' ability to produce and store food was one of the most important advances in the history of civilization. Before people started growing their own food, they gathered fruits, nuts, berries, and plants, and hunted wild animals. They feasted when they found plenty of food. But they starved if the weather or some other problem kept them from finding food. These hunter-gatherers often moved from place to place in search of food.

When humans learned to grow their own food, they could often stay in one place during the growing season. But they still had to find food after the growing season was over. After people found ways to preserve food, even for short periods, their lifestyles changed. People who could produce more food than they needed in a day had extra time and energy. They were able to use this free time for other things, like science and art.

Young people will also realize that the industrial age brought with it many changes in the way people produce and distribute food. Worldwide transportation allows people to eat foods that do not grow nearby. These changes have affected what people eat and how much time they spend preparing food. They also affect the safety of our food supply. In the process of growing large amounts of food and shipping it all over the world, illnesses are sometimes spread to many people.

Many learners will find that their families have recipes for preserving foods. Grandparents and great-grandparents might have passed them down from one generation to the next. These traditions can help learners understand the history and roots of their families. It can also help them see how local conditions have influenced cultures and history around the world.

Humans have been preserving foods since 15,000 to 10,000 B.C. Some ways of doing this are freezing, freeze-drying, fermentation, and using herbs and spices.

Of course, people who lived thousands of years ago didn't have freezers and refrigerators. But scientists have found mammoths and other large mammals stored deep underwater. The cold water temperatures preserved meat for years. Archeologists have also found meat frozen in pits or in the colder parts of caves.

Today, companies use a process called *freeze-drying* to make products like "astronaut ice cream" and instant coffee. But people in South America were freeze-drying potatoes thousands of years ago. Natives carried potatoes high up into the Andes Mountains. They sliced and crushed the potatoes to a pulp. Then they spread the pulp on rock and left it overnight. The next morning, they returned to gather the freeze-dried potatoes. This method worked high in the mountains, where the atmospheric pressure is low, the air is very dry, and nighttime temperatures are below freezing.[1]

Another method, fermentation, has been used since 6000 B.C. It is used to produce breads, vinegar, cheese, and yogurt.[2]

People have also used spices and herbs as preservatives for thousands of years.

Here are just a few of the topics learners will explore during this project: What makes different methods of food preservation work? What is the role of pH, osmosis, air pressure, bacteria, mold, fungi, and irradiation? How is food preservation changing? Why can't people always trust food safety instructions that were written as recently as five years ago?

Cautions

The purpose of this project is not to teach home food preservation. It is not a recipe book. Instead, this project introduces learners to the techniques used to preserve food. It also helps them understand the science and technology behind the techniques. Many books and other sources give step-by-step directions for canning, freezing, dehydrating, or salting different foods.

Learners should check up-to-date resources on food safety. Knowledge about foods, food preservation, and disease-causing substances found in foods is changing quickly. But keep in mind that the goal of this project is not to conduct an in-depth course in microbiology.

The information included here is not meant to unduly alarm learners about our food supply. But they should learn how to look at data and make informed choices about what they eat. They should be aware of the risks and benefits of various preservation techniques, additives, and food-growing processes. They should also realize that most bacteria are beneficial. Usually, food safety issues focus on harmful bacteria, but some bacteria help people stay healthy. Learners should also realize that all foods are composed of chemicals. Chemicals that are added to foods carry with them some costs and some benefits.

Activities: Brief Descriptions

This project has 10 activities:

Activity 1: A Survey in My Kitchen. This activity introduces learners to food preservation. They survey a kitchen to find examples of preservation techniques.

Activity 2: pH, Pickling, and Osmosis. Measure the pH of foods and saliva. Pickle your own finger. Find out why a pickle is not just a cucumber in water. See osmosis in action.

Activity 3: Mold, Fungus, and Bacteria. How many different ways can you make an egg grow fuzz?

Activity 4: Dehydration. How much weight can an apple lose when the water is removed? Build a homemade food dehydrator.

Activity 5: Canning, Pressure Cooking, and Air Pressure. The pressure is on! Why do we sometimes cook food in a pressure cooker? Learn some properties of air pressure.

Activity 6: Refrigerating and Freezing Foods. What's the burn? Wrapping and storing foods properly.

Activity 7: Can You Find the Food Additives? Search for chemicals added to common foods.

Activity 8: Fermentation—What a Cheesy Idea! Capture a yeast strain. Make your own yogurt.

Activity 9: Controversial Questions on Food Safety and Preservation. A fishbowl activity helps learners discuss different ideas and opinions with respect.

Activity 10: Food Jeopardy! A game to keep you out of jeopardy.

Materials. A list of materials is included with each activity. The Materials Summary (page 3-52) lists everything needed for all activities.

Why Study Uses of Herbs?

Benefits for Learners

Today, most Americans do not spend much time thinking about food preservation. But having a year-round supply of good food is vital. If we save food when it is plentiful, we will not starve in times when food is less plentiful. There are several reasons young people should be interested in this issue:

- Many young people wonder how people might solve the problem of world hunger. They may be surprised to learn that simply growing more food is not the answer. Food shortages in some areas of the world are often caused by poor food preservation and distribution. Up to a third of the harvest in some countries is lost before it ever gets to the people who need it.

- Reports of contaminated food are common. News reports often talk about people getting sick because of *E. coli*, salmonella, and listeria in their food. The way food is produced and distributed will continue to affect young people in the future.
- The science of food preservation involves microbiology, chemistry, and physics. Practical concerns include taste, texture, storage space, available technology (freezers, pressure cookers, etc.), and planned uses. Both scientific and practical knowledge can help young people explore a variety of careers. Some food-related careers require years of formal education, and some do not.
- In rural areas, many people still can, freeze, dry, or pickle their own food. By doing activities related to food preservation, learners see that family members, especially women, use science at home. Science is essential to daily life. Studying food preservation can also connect learners to family traditions and history. They might even conduct research and oral histories.

Skills. This project helps learners develop skills they can use throughout life:

- collecting and analyzing data
- developing arguments that use research and data
- making observations
- making inferences
- designing and evaluating experiments
- decoding food labels
- doing estimations

Topics and concepts. This project addresses many scientific topics and concepts:

- pH, acids, bases
- osmosis
- air pressure
- microbiology
- pressure cooking
- heat and temperature
- food additives
- freezing and refrigeration
- safe food preparation and storage
- molds, bacteria, fungi
- food irradiation
- dehydration
- fermentation

Career links. As young people learn about food preservation, they will discover new career possibilities. Some examples are food science, anthropology, history, agricultural extension, microbiology, health care, food and agriculture policy, pest management, economics, food preparation, and hygiene or public health. There are several things you might do to help learners explore these career possibilities. Take them on a trip to a local farm or food processing plant. Go to a local grocery store to find out how food is preserved there. Find out what stores do with food that is spoiled or out of date. Arrange a visit to your local public health service. Invite an extension agent to demonstrate food preservation techniques to your group. Find out how archeologists use the remains of foods to learn about ancient culture, geographic range, climate, and diet. Ask local fast food restaurants to explain how they prevent food poisoning.

Compliance with national science standards. This project addresses the following National Science Education Content Standards for grades 5–8:

Content Standard A: Abilities Necessary to do Scientific Inquiry

- Use appropriate tools and techniques to gather, analyze and interpret data
- Develop descriptions, explanations, predictions and models using evidence

Content Standard B: Physical Science

- Properties and changes of properties in matter
- Transfer of energy

Content Standard E: Science and Technology

- Understandings about science and technology

Content Standard F: Science in Personal and Social Perspectives

- Personal health
- Risks and benefits
- Science and technology in society

CAUTION

Safety Note:

Activities involving food should not be done in a laboratory where chemicals are used or stored for nonfood purposes. If your group or class usually meets in a laboratory, arrange to hold the meeting in another room instead. A cafeteria or kitchen is a good place to meet whenever you have food that will be eaten.

Benefits to the Community

Contaminated food or water can make thousands of people sick at one time. When food poisoning is reduced, communities are healthier. Fewer people miss work. Fewer people spend time and money in doctors' offices. Young people who do this project will have some ideas about how to make the local food supply safer. The whole community can benefit when learners share this knowledge.

Learners can find out a lot about local culture, history, and technology as they interview people in their community. They begin to see the adults they know as sources of important knowledge. Learners can also help community members appreciate one another's wisdom and knowledge.

They can present their knowledge in fairs, community centers, grocery stores, or other places.

Ideas for Additional Projects

Young people might enjoy finding out what technologies for food preservation were used 200 years ago. If possible, bring in old equipment and ask learners to identify it. Or you might visit an Amish hardware store. Identify which tools require electricity and which ones don't. Discuss how our lives might be different if we didn't have refrigerators.

Visit a farm that has a smokehouse. Find out how foods are smoked and how foods are cured. Learn why most smokehouses have dirt floors. Discover why hogs are usually slaughtered in late autumn in the southeastern United States. Explore a root cellar. Find out what types of foods do well in cellars.

Learn about the process of potting meat. Find out why potting is not usually seen as a good idea now. Explore other techniques that are not addressed in this guide: smoking, curing, root cellaring, carbonation, and pasteurization.

Make a list of all the ingredients in one lunch. Then try to find out where in the world this meal came from. See if you can trace the ingredients back to the farms that produced them. On a map, mark the areas of the world that contributed to your lunch.

This project guide does not discuss oxidation or rancidity. These chemical processes can change the quality of foods. Encourage learners to find out more about these processes and how to slow them.

Readings for Young People

The Canning Season by Margaret Carlson (Kimanne Smith, illustrator). Ages 4-8. Minneapolis: Carolrhoda Books, 1999.

Angels in the Dust by Margot Theis Raven (Roger Essley, illustrator). Ages 4-8. Mahwah, NJ: Bridgewater Books, 1999.

Back Home by Gloria Jean Pinkney (Jerry Pinkney, illustrator). Ages 4-8. New York: Dial Books for Young Readers, 1992.

The Barn by Avi. Ages 9-12. New York: Orchard Books, 1994.

More Science Experiments You Can Eat by Vicki Cobb (David Cain, illustrator). Ages 9-12. New York: HarperCollins, 1994.

Milk: From Cow to Carton by Aliki. Ages 4-8. New York: HarperCollins Juvenile Books, 1992.

Bread Bread Bread (Around the World Series) by Ann Morris (Ken Heyman, illustrator). Ages 4-8. New York: Mulberry Books, 1993.

The Popcorn Book by Tomie De Paola. Ages 4-8. New York: Holiday House, 1989.

Corn Is Maize: The Gift of the Indians by Aliki (illustrator). Ages 4-8. New York: Cromwell, 1976.

Eat Your Words: A Fascinating Look at the Language of Food by Charlotte Foltz Jones (John O'Brien, illustrator). Ages 9-12. New York: Delacorte Press, 1999.

Eating the Plates: A Pilgrim Book of Food and Manners by Lucille Recht Penner. Ages 4-8. New York: Macmillan, 1991.

Food: Its Evolution Through the Ages by Piero Ventura. Ages 9-12. Boston: Houghton Mifflin, 1994.

Food: How We Hunt and Gather It, How We Grow and Eat It, How We Buy and Sell It, How We Preserve and Waste It and How Some Have Too Much and Others Have None by Milton Meltzer, (Sharon Lane Holm, illustrator). Ages 9-12. Brookfield, Ct: Millbrook Press, 1998.

Food Safety (True Book) by Joan Kalbacken. Ages 4-8. San Francisco: Children's Press, 1998.

It's Disgusting—And We Ate It! True Food Facts from Around the World—And Throughout History! by James Solheim (Eric Brace, illustrator). Ages 4-8. New York: Simon & Schuster Books, 1997.

The Science Chef Travels Around the World: Fun Food Experiments and Recipes for Kids by Joan D'Amico (Karen Eich Drummond, contributor; Tina Cash-Walsh, illustrator). Ages 9-12. New York: John Wiley & Sons, 1996.

The Science Chef: 100 Fun Food Experiments and Recipes for Kids by Joan D'Amico (Karen Eich Drummond, contributor; Tina Cash-Walsh, illustrator). Ages 9-12. New York: John Wiley & Sons, 1994.

Leader Background Information

Food Preservation, History, and Culture

People around the world preserve various foods in different ways. We learn a lot about history and cultures when we study why and how people preserve certain foods.

Maize, or corn, has been very important to the native people of North America. It made up about 80 percent of the traditional diet of many Native Americans. Native women developed corn by crossbreeding grasses and weedy seed plants. They have been doing this for thousands of years.[3] Maize shows up in Mayan creation stories, worship, and myth. For example, Mayan legends say that humans came from sacred ears of maize. They describe humans as a cornfield ready to serve the creator. Native peoples thrived on a diet made up mainly of corn and beans. They created many ways to preserve and cook food. Native peoples sun-dried corn to make hominy. They ground it into meal to make tortillas and other foods.

Sausage making is another ancient way to preserve food. People have been making sausage for centuries in the Chinese, Greek, Roman, and Babylonian cultures. Roman butchers formed guilds to keep their people from finding out how they salted, spiced, and dried their sausages.[4] People in different parts of the world made sausage in various ways. For example, in cold climates, people often smoked sausage. In warm climates, spices were added to preserve the meat. People also used local ingredients to flavor their sausages. Sometimes, towns became known for the flavor or type of sausage they made.

Salt has been used as a chemical preservative since ancient times. It was used to preserve meat in Europe during the Middle Ages. Food for farm animals was often so scarce during the winter that many of them were butchered and salted. Only a few animals were kept alive so that they could breed. Meat preserved this way is very high in salt. It is probably a good thing that many people in Europe did not eat meat during the season of Lent in the spring. It might have kept many people from having high blood pressure and other problems caused by eating too much salt.

Kim chee, or kimchi, is so important in Korean life that the food has been named a national treasure. Kim chee is made up of vegetables (often Chinese cabbage) pickled in salt, red peppers, and garlic. It is similar to sauerkraut, which is made with green cabbage. Kim chee is high in vitamins C and B.[5] It is also very spicy.

All of these ways of preserving food affected people's lives in several ways. Some of the effects are surprising.

For example, some scientists think that witch hunts might have been triggered by food poisoning from ergotism.[6] Ergotism is a disease caused by a fungus that affects grain. It can cause people or animals to have seizures, "see things" that aren't really there, fear others, or even die. Sometimes, people thought things like this were caused by witchcraft. Witch hunt crazes almost always started after cool, rainy, growing seasons. This kind of weather helped produce the ergot poison in food supplies.

People don't usually connect food preservation to building cities or fighting wars. But a steady food supply is vital to both efforts. Napoleon offered a prize to anyone who could come up with a way to provide a steady supply of safe food to his troops. The winner was Nicholas Appert, who developed canning. He experimented with canning in the 1790s and tested it widely. In 1809 he claimed the prize. Appert believed that air and fermentation caused food to spoil. He did not realize that the canning process worked because of the process he used, which killed microorganisms. It was not until the 1860s that Louis Pasteur used the microscope to prove that microorganisms existed. He was finally able to explain what made food spoil. So the technology of canning existed for almost 70 years before science could explain why it worked.[7]

According to the Centers for Disease Control, more than 250 types of bacteria, viruses, and parasites can cause food-borne illnesses.[8] In 1994 there were between 6.5 and 33 million cases of food-borne illness and about 9,000 deaths from food poisoning in the United States.[9] These illnesses cost $1 billion to $10 billion each year.[10] Some food-borne illnesses are declining. But others are becoming more common. Two examples are salmonella and a fatal strain of *E. coli*.[11]

These increases are caused partly by changes in the ways animals are raised. The way foods are processed and shipped also makes a difference.

Back when most food came from small farms, outbreaks of disease were limited to a small area. Now, meat from a single diseased cow can be distributed throughout the world. Thousands of people can suffer. Vegetables grown in a single field irrigated with contaminated sewage can cause illnesses in many countries. One hamburger from a fast food restaurant may contain meat from dozens of states and more than one country. There is often no way to know which foods come from contaminated places.

New strains of harmful microorganisms make it hard to keep food safe. For example, the *E. coli* bacteria that live in human and animal intestines are normally helpful. They produce vitamins. They can keep harmful bacteria from growing.[12] But human and animal waste products that contain these bacteria can contaminate meat. The result can be deadly. In 1982 a new strain of *E. coli* was recognized. It was labeled *E. coli 0157:H7*. The most famous *E. coli 0157:H7* outbreak caused three deaths and hundreds of illnesses among people who ate hamburgers at a fast food chain. Millions of pounds of ground beef have been recalled due to *E. coli* contamination. The bacteria can also live in swimming pools. As few as 10 to 100 *E. coli* bacteria are enough to cause a fatal illness in swimmers who ingest them.[13] Illness or death can also be caused by an invisible amount of fecal material in meat or on vegetables and fruits. So the impact of just one type of harmful microorganism can be enormous. The global food distribution system can spread their impacts across the world.

An Introduction to Microscopic Life Important to Food Safety

The human population increased greatly after the microscope was invented. Why? The microscope allowed us to look at tiny organisms that are sometimes found in foods. For the first time, we could study these microorganisms. We learned about which ones could make us sick. We discovered ways to keep them from contaminating our food. As a result, fewer people died of food poisoning.

Most food poisoning is caused by organisms that are found naturally in food, air, or water. Bacteria cause most contamination problems. Molds and viruses also cause food-borne diseases. There are many new antibacterial products on the market. Learners may wonder why people can't use them to kill all the nasty germs and eliminate the problems. To know why this isn't possible, it is important to know a little about the organisms that cause food poisoning. Here is a brief introduction.

Fungi are organisms that get food by directly absorbing nutrients. They do not undergo photosynthesis.[14] Fungi were once considered plants, but now they are seen as a completely separate group. Fungi can consist of one cell or many. You can see some with the naked eye. You must use a microscope to see others. More than 100,000 species of fungi have been identified. More than a million species may exist.[15] Mushrooms and puffballs are examples of fungi. They are some of the largest living organisms on earth. For example, one fungus has been found that covers 1.6 million square feet and weighs about 200,000 pounds. Yeasts are microscopic fungi. In breads, yeast turns starch into sugar. When the yeast then digests the sugar, it produces gases and water. This is what causes bread to rise. Other small fungi are useful in fermentation. They are used to produce cheeses and to make many medicines.

Mold is a fuzzy growth on organic matter. It is produced by several types of fungi. Mold begins as microscopic spores that spread through the air. People used to believe that it was safe to eat moldy food if they cut off the moldy part. Now we know that in many cases this is *not* true. Some molds even contain cancer-causing agents.[16]

Heating or cooking moldy foods does not make them safe. The furry or fuzzy fibers grow down into the food in tangled masses. The fibers can be so small that you can't see them without a magnifying glass. All soft foods with mold should be thrown away. These include breads, lunch meats, dairy products, leftovers, peanut butter, grains, leafy greens, nuts, seeds, and juices. You may be able to salvage some harder foods by trimming off the moldy areas plus an additional 1-1/2 inches. Foods you may try to salvage include apples, pears, carrots, potatoes, turnips, broccoli, cauliflower, cabbage, smoked meats, and country ham.

Bacteria are single-celled microscopic organisms. They are very small and are less complex than fungi. Bacteria use fermentation or respiration to make energy from organic compounds such as sugars. They can also use inorganic compounds such as ammonia or hydrogen sulfide. Bacteria are among the oldest forms of life on earth. They have existed for more than 3.5 billion years.[17] There are thousands of species of bacteria. Most are harmless. A few cause diseases in humans or animals. Together with fungi, bacteria are responsible for the decay of all organic matter.

If conditions were just right, one bacterium could reproduce to make two bacteria in 20 minutes and four in 40 minutes. Doubling can make the numbers add up quickly. If the right food and space were available, one millionth of a gram of bacteria (less than 0.000000002 ounces) could produce 1,000 tons of bacteria in 14 hours! Fortunately, the perfect conditions for growing bacteria do not exist in real life. But in poor growing conditions, some bacteria can form hardened "shells" called spores. Spores are very difficult to kill. They can survive boiling in water, the vacuum of space, and going without nutrients for decades.[18]

Bacteria That Play a Role in Food-Borne Diseases

Salmonella is widespread in animals, especially poultry, swine, dairy products, and seafood. Salmonella bacteria are also found in water, soil, insects, factory surfaces, and kitchen surfaces. There are 2 to 4 million cases of salmonella poisoning in the United States each year. Most of these cases are caused by contaminated eggs. Salmonella poisoning has increased sixfold in the past decade in some parts of the country.[19] Older recipes for ice cream and eggnog often use uncooked eggs. Such recipes used to be fairly safe, but now they are unsafe because salmonella has become a poultry epidemic. Eggs should always be cooked until the yolk is firm. Raw cookie dough, cake batter, Caesar salad dressing, and homemade mayonnaise can transmit salmonella if they contain raw eggs. The USDA reports that before special procedures began to be used in 1998, salmonella was in about 20 percent of broiler poultry and 50 percent of ground turkey. By 1999 salmonella contamination had dropped to 11 and 36 percent respectively, because of the new procedures.[20]

E. coli 0157:H7 can be a deadly strain of the *E. coli* bacteria. *E. coli* live in the intestines of all animals, including humans. *E. coli* bacteria are beneficial. They make vitamins and crowd out more harmful bacteria. Illnesses related to harmful strains of *E. coli* come from fecal contamination. Meats, vegetables, fruits, or raw milk can be contaminated when they contact animal waste products. The bacteria can also be spread through person-to-person contact. Most cases of *E. coli O157:H7* come from consuming ground beef, milk, or unpasteurized fruit juices that were contaminated during processing. When meat is further processed, the bacteria can spread through a large volume of meat. A similar problem can occur with venison. Several deaths from *E. coli 0157:H7* occur each year in the United States.[21]

Botulism is caused by a bacteria that is widely distributed in nature. It can be found in poultry, cattle, horses, fish, improperly canned foods, luncheon meats, canned vegetables and meats, soils, waters, and sediments.[22] Botulism bacteria produce a neurotoxin that can lead to severe or fatal food poisoning. Botulism bacteria can be killed by heat. Cases of botulism poisoning are most often associated with home-canned foods that were not processed the right way. Botulism should be of concern with almost any food that is not very acidic, such as mushrooms or some tomatoes.

Clostridium perfringes belongs to the same genus as the botulism organism, but it produces a less severe disease. The bacteria are found in soil, water, and unprocessed foods. They are also in the intestinal tracts of both animals and humans.[23] Clostridium spores can survive boiling for hours. They can even thrive in cooked foods. Many cases of clostridium poisoning happen on holidays, when food is often left on the table for hours. It also happens in institutions where food is prepared hours before it is served. Illness can occur when meats spend several hours at room temperature or when large pots of meat, gravy, stews, or casseroles are cooled too slowly in the refrigerator. Clostridium perfringes is one of the most commonly reported types of food poisoning. According to estimates from the Centers for Disease Control, there are about 10,000 cases each year in the United States.

Listeria bacteria have caused several massive food recalls of products such as hot dogs and cheese. Listeria is hardy. It resists freezing, drying, refrigeration, salt, nitrates, and acidity. Fortunately, most healthy people only get flu-like symptoms when poisoned by Listeria. However, Listeria can kill the young, elderly, or ill people. It can also cause miscarriages.

Listeria bacteria thrive in cold temperatures. Outbreaks of Listeria-related illness can often be traced back to prepared salads, cheese, unpasteurized milk, or some seafoods.[24] Listeria bacteria are carried by many birds and mammals, including 1 to 10 percent of humans.

Staphylococcus bacteria exist just about everywhere. In humans and animals, they are found on the skin, hair, and mucous membranes of the nose and throat. Boils, abscesses, pimples, and other skin inflammations and infections may be caused by (or contain) the staphylococcus bacteria.[25] Staphylococcus, or staph, bacteria are widespread in untreated water, raw milk, and sewage. Staph is one of the first types of bacteria to have developed strains that are immune to our strongest antibiotics.[26] Staph bacteria pose particular problems in meat, poultry, eggs, tuna/egg/chicken/potato/macaroni salads, and cream-filled foods.[27] Foods that are handled a lot during preparation are more likely to be contaminated. The staph bacteria themselves can be killed by heat. But illness is actually caused by a toxin or poison produced by the bacteria. This toxin is not killed by heat. So it is important to control the growth of staph rather than attempt to kill it off afterward.

Shigellosis bacteria are found in the intestines and stools of infected people.[28] Infected people can contaminate food when they do not wash their hands after using the toilet, then handle liquid or moist food or water. The bacteria are spread by direct contact with an infected person, by eating or drinking contaminated food or water, or by contact with a contaminated object.

Campylobacter bacteria contaminate 20 to 100 percent of ground chicken and 90 percent of turkeys. For years scientists thought campylobacteriosis was mainly a problem for nonhuman animals. Recently, researchers have realized that illness from campylobacteria affects 2 to 4 million Americans each year.[29] The bacteria are found in the intestinal tracts of poultry, cattle, and sheep. They are also in unpasteurized milk and raw shellfish. "Campy" is easily killed by heat. Its growth is slowed or stopped by salt, acid, and drying.

Parasites and Viruses

Parasites are "freeloaders." These organisms depend on another organism for survival usually without contributing anything to that organism. Parasites are much larger than bacteria and viruses, but they may still be microscopic in size. Three parasites found in water can affect food safety—cyclosporae, cryptosporidia, and giardia.[30] These protozoa can contaminate food that is washed with infected water. Contamination can also occur when the food is growing or when it comes in contact with unwashed hands. Cryptosporidia sickened more than 400,000 people in Wisconsin in one outbreak. Another outbreak killed at least 20 people in Las Vegas.[31]

Viruses are the smallest and simplest forms of life. Viruses are genetic material surrounded by a coat of protein. They cannot move or reproduce on their own. Instead, they invade a host cell and turn that cell into a virus factory by injecting genetic material into the host. There is no effective treatment or cure for diseases caused by viruses. Two types of viruses are often mentioned in connection with food safety, the Hepatitis A virus and the Norwalk virus. The Hepatitis A virus may be found in raw shellfish and mollusks contaminated by untreated sewage. Sandwiches, salads, juices, and drinks can also carry the virus. Cooking doesn't always kill it. The Norwalk virus thrives in human feces. Like Hepatitis A, it can be present in raw shellfish taken from polluted waters. Foods such as salads and sandwiches prepared by infected people can also transmit the Norwalk virus.[32]

Killing Harmful Microorganisms

Getting rid of or controlling food-borne harmful microorganisms is not always easy. But there are many steps you can take to protect yourself. Remember that thorough cooking kills most food-borne bacteria, viruses, and parasites. You can cut down on eating processed foods by eating locally grown foods in season and grinding your own hamburger. This will reduce exposure to harmful bacteria. You can also use disinfectants. But disinfectants and antibacterials do not provide an answer to all food-borne illnesses.

Products labeled "antibacterial" do not kill all the bacteria present on an object. Most of these products advertise that they kill 99.99 percent of the bacteria present. This is indeed a high percentage. But bacteria are so small and can exist in such high numbers that these products may still leave thousands of bacteria present. For example, if a hand has 10 million bacteria on it to begin with, 1000 bacteria would remain after it has been washed with an antibacterial product. Even more would be left if the hand was not washed thoroughly. Even the process of sterilization may not remove all bacteria. The official definition of sterilization allows one bacteria to survive from a starting count of 100 million. In general, it is easier for disinfectants to kill bacteria than to kill viruses, fungi, and spores.

There is another safety issue to consider. Disinfectants act by poisoning biochemical activities in the cells of microorganisms. However, humans share many of the same basic biochemical activities and pathways. The better a disinfectant is at killing microorganisms, the more likely it is to have side effects in humans and other animals.

Overuse of antibacterial products poses other problems as well. Overuse could lead to the development of new strains of resistant bacteria. This has already happened with many antibiotic drugs. So, if not used wisely, the products we use to fight harmful bacteria could lead to the development of even more harmful bacteria.

Activity 1

A Survey in My Kitchen

Leader Notes

This activity will introduce learners to the topic and help them appreciate the impact of food preservation in their lives.

Key Questions

- Why is food preservation important to my daily life?
- How are the foods I eat every day preserved?
- How were foods preserved in the past in my community?
- How has our diet changed due to new ways of growing, processing, and transporting food?

Handout 1-1 briefly overviews common food preservation methods.

After learners become familiar with the methods discussed in Handout 1-1, give them each a copy of Handout 1-2. They will use this handout as they survey a kitchen. On the form, they will list all the foods, condiments, and spices they find. They will note how they believe the food is preserved. And they should predict how long they think each food item will remain edible. If learners do the survey at home or elsewhere, they should bring Handout 1-2 to the next meeting for a discussion.

If your group includes young people who are homeless or live in shelters, modify this activity. You might ask learners to survey a kitchen at your meeting place, for example.

Point out that a single food may be preserved by multiple means. For example, vegetables might be canned *and* contain chemical preservatives. Spices may be dried *and* irradiated. Foods may be frozen *and* contain additives. Pickles are both fermented *and* canned.

Point out that in the United States most spices are irradiated. Generally, this informa-

Materials Checklist

☐ Handout 1-1 (1 per learner)

☐ Handout 1-2 (1 per learner)

Approximate Time Required

Survey, 1 hour (outside of program time)

Discussion and sharing, 20-30 minutes

Field trips and/or visits by home food preservers to explore old food preservation technologies, time varies depending on activity

Environmental Note

Recycle paper when finished.

What to Do in Advance

☐ Read leader background information on food preservation, history, and culture.

☐ Arrange visits and/or field trips.

☐ Copy Handouts 1-1 and 1-2.

< Definition

irradiation is the process of using radiation to preserve food. For a more detailed description, see Activity 9.

tion is not provided on the label. Some fruits and vegetables are bred or genetically engineered to have a longer shelf life. This is not, however, a method of food preservation.

Select some common foods. Explore the various ways they are preserved.

If you live in a community where many people preserve foods at home, have learners tell about their own involvement in these efforts. Ask them if they have seen or done any of the following: canning, freezing, drying, making jerky, smoking, salting, root cellaring, or fermentation. Tell learners that any time they store food, they are probably using some type of preservation.

Is there someone in your community who cans or dries foods? Invite that person to tell the class about his or her experiences. Have learners interview older people to find out what foods they preserved when they were younger and how they did it. Do some research into what foods were the mainstays of the diet in your community 100 years ago (or more). How were these foods preserved? How did diet change with the seasons? Learners should write questions they can use to interview guests. They may also want to take pictures and record stories. These could be used to create newspaper articles, Web pages, scrapbooks, or posters. The group could do an exhibit at the end of the project.

Save Handout 1-2 to revisit at the end of this project. After they have completed the remaining activities, learners will have new insights on the data they collected in this activity.

Activity 2

pH, Pickling, and Osmosis

Leader Notes

This activity introduces learners to the concepts of pH, acidity, basicity, and osmosis. They learn about the process of pickling. When foods are pickled, they are preserved in an acidic solution to keep microorganisms from growing. You may want to bring in containers of pickled items such as cauliflower, onions, eggs, pigs' feet, and sauces. Learners will see that pickling is used for much more than pickles.

Key Questions about pH

- What is pH?
- What does pH have to do with food preservation?
- Why is the pH of saliva relevant to food safety?

This activity is in two parts—pH measurement and an osmosis demonstration.

pH is an important concept in food preservation and other areas of chemistry. The greater the acidity of a substance, the lower the pH value. Usually, the measurements are taken for liquids. A pH of 0 means a substance is very, very acidic. A pH of 14 means a substance is very, very basic. A pH of 7 is neutral. Acids are tart and tangy. Bases are slippery like soap.

Around your house, you will find that most cleaning agents are basic. They have a pH of 8 to 14. In your refrigerator, you will find that most foods are acidic. They have a pH of 2 to 6.5.

Allow learners enough time to test the pH of various solutions. They will want to test more solutions than the ones listed. If you are in a laboratory or have a pH meter handy, you may want to use both pH paper and the meter. Then explore with learners the advantages and disadvantages of each measurement tool. If

Materials Checklist

pH measurement

☐ Handout 2-1 (1 per learner)

☐ Handout 2-2 (1 per learner)

☐ Small plastic cups to spit saliva into (1 per learner)

☐ Solutions for measuring pH:

Lemon juice (1/2 ounce per group)

Tap water (1/2 ounce per group)

Deionized water (1/2 ounce per group)

Cider vinegar (1/2 ounce per group)

Distilled vinegar (1/2 ounce per group)

Milk (1/2 ounce per group)

Dill pickle juice (1/2 ounce per group)

Citric acid solution, mixed from powder (optional)

Ascorbic acid solution, mixed from powder (optional)

☐ pH paper (1 vial) (Note: You can get pH paper from science supply catalogues; places that sell swimming pool supplies; and some medical, gardening, nutrition, farm, craft, and restaurant supply stores.)

☐ pH meter (optional)

☐ Squirt bottle of deionized water (to rinse pH meter, if used)

☐ Tissues (if pH meter is used)

☐ Small plastic cups or beakers (1 for each liquid tested)

☐ Kitchen timer

you do not have a pH meter available, pH paper will work just fine.

If you are in a classroom setting, you may want to extend the activity to natural acid/base indicators, such as those in red cabbage, blueberries, hydrangeas, and many other flowers and plants. You can explore natural indicators at this point, or come back to the topic later as learners develop their understandings of pH.

Citric and ascorbic acid powders can be found in many places that sell canning supplies. It is not necessary to use either solution in this activity. Don't worry if you cannot locate these easily.

Learners should draw straws to decide who will get "pickled." The chosen learner places an index finger in a cup of cider vinegar and keeps it there for 10 minutes. Ask another learner to keep track of time using a kitchen timer. During this time, the learners can move on to other tasks. After the 10 minutes have passed, however, ask them to observe the pickled finger. The shriveling is caused by osmosis. Water flowed out of the learner's finger and into the vinegar, which is a more concentrated acetic acid solution. Being "pickled" may limit one learner's participation in the other tasks for 10 minutes. But keep the learner as involved as possible.

Have learners label cups or beakers with the names of the solutions they will be measuring. Select from the following liquids or add other food-based solutions:

lemon juice
tap water
deionized water
cider vinegar
distilled vinegar
milk
dill pickle juice
citric acid solution
ascorbic acid solution

Osmosis demonstration - Method A

- ☐ Handout 2-3 (1 per learner)
- ☐ Handout 2-4 (1 per learner)
- ☐ Sausage casing or dialysis tubing (approximately 6 inches)
- ☐ Pancake syrup (approximately 3 ounces)
- ☐ String (6 inches)
- ☐ Tall, narrow, clear container, such as a graduated cylinder
- ☐ Water
- ☐ Sliced dill pickles for sampling (1 for every 4-5 learners)
- ☐ Sliced cucumbers for sampling (1 for every 4-5 learners)

Osmosis demonstration - Method B

- ☐ Eggs (2)
- ☐ Vinegar (enough to cover eggs)
- ☐ Container for eggs and vinegar
- ☐ Water
- ☐ Container for water and egg
- ☐ Corn syrup
- ☐ Container for corn syrup and egg
- ☐ Large spoon

Approximate Time Required

pH, 45 minutes

osmosis, 30 minutes

Environmental Notes

The pH paper and sausage casing or dialysis tubing can be disposed of in the trash.

Use small amounts of solutions. Wash remaining solutions and syrup down the sink.

What to Do in Advance

- ☐ Read "Leader Background Information—Introduction to Microscopic Life Important to Food Safety."
- ☐ Copy Handouts 2-1 through 2-4.

Have learners pour about half an ounce of each liquid into its labeled cup. Keep amounts small to cut down on waste.

Learners should measure the pH of each liquid using pH paper and, if available, a pH meter. Have them record the pH on Handout 2-1.

Provide Handout 2-2 to learners. Have them line up the liquid cups in order, from the most basic to the most acidic.

To measure the pH of saliva, each learner should spit saliva into a clean cup, dip the pH paper into the cup, and record the measurement.

Ask learners to discuss the following questions.

Are any of the pH readings for the liquids surprising? Learners may be surprised that distilled water generally is not pH 7 (neutral). Deionized water and freshly distilled water should be about pH 7, but, over time, gases from the air (oxygen, carbon dioxide, etc.) and even chemicals from the plastic container may dissolve in the water and change the pH. It is still safe to drink.

Lemon juice is acidic. It might have a pH of 2. Vinegars also have low pH values.

Why is the pH of your saliva relevant to food safety? The pH of saliva is generally between 4 and 6.5—acidic. When food mixes with saliva, some microorganisms are killed by the acidic pH. This is one way our bodies protect us from these "germs" or "bugs."

Key Questions about Osmosis

- What is osmosis? Why is it relevant to food preservation?
- What are some real-life examples of osmosis?
- When making a pickle, does water flow into or out of the cucumber?
- Which is safer to eat: (1) a cucumber sitting in water in a sealed jar or (2) a pickle?
- What are some advantages and disadvantages of pickled food?

Osmosis is the movement of molecules across a semipermeable membrane so that the concentration of liquid on both sides of the membrane is equalized. A semipermeable membrane has very, very small (microscopic) holes on it. Some examples are the skin of a vegetable, fruit, person, hot dog, or balloon. Some molecules travel through these small holes from one side to the other.

For example, fill a sausage casing (semipermeable membrane) with pancake syrup (large molecules of sugar). Suspend the casing in water (small molecules). Since water molecules are smaller than sugar molecules, the water molecules can pass through the casing. They will move into the casing and dilute the pancake syrup inside. In this case the syrup cannot move out of the casing.

Use Handout 2-3 as a guide to setting up the demonstration. This handout also tells learners about osmosis.

It is easy to convert the osmosis demonstration to an activity. But be prepared for a sticky mess if you do! Learners *will* spill syrup on their clothing and surroundings. The additional time spent in cleaning up, if this is done as a learner activity rather than a demo, may not be worth the gains. For easier cleanup, put the syrup in the sausage casing or dialysis tubing while working over a sink.

Sausage casing can be obtained at butchers' shops, meat packing houses, stores that sell hunting supplies, stores that cater to home food preservationists, and via mail or the Internet. You can use dialysis tubing in place of sausage casing. Dialysis tubing can be obtained at medical supply stores. Because only a small amount is needed, you may be able to get it donated from a hospital or supply house.

You do not need to have a graduated cylinder to do this activity. Any tall, clear, relatively narrow container will do. Measure the amount of water in the container before you begin. Mark the level on the container before you lower the casing into the water. Compare the water level after you remove the casing to the level you initially marked.

Another way to demonstrate osmosis is to soak two eggs in vinegar for 48 hours. Use eggs that are about the same size. After they have soaked long enough, use a spoon to carefully put one egg in water. Put the other egg in thick corn syrup. Have learners observe the eggs after 30 minutes and after 1 hour. The egg placed in water will appear larger than the other one. Why? While eggs are soaked in vinegar, acid dissolves the calcium carbonate that makes up most of the eggshell. The thin membrane that remains around the egg is semipermeable, which makes osmosis possible. Water flows *into* the egg placed in water, making it bigger. Water flows *out of* the egg placed in corn syrup, making it shrink.

Point out that living cells have semipermeable membranes. Through these membranes, water moves from a less-concentrated to a more-concentrated solution. This is called osmosis. Osmosis is what makes it possible to preserve foods by pickling them. If bacteria are placed into a highly concentrated pickle or jam, water moves from bacteria cells into the pickle or jam. The bacteria, which are 90 percent water, die from water loss.

Other examples of osmosis are all around us. Lawns that get too much fertilizer dry up and sometimes die as water moves from the cells of the grass into the soil. If sea urchin eggs are removed from the ocean and placed in fresh water, they swell up and may burst as fresh water moves into the egg.

Salting is another preservation technique that depends on osmosis. In salting, food is treated with salt or a strong salt solution. Water is removed from the food by osmosis. Microbes cannot grow without water, so the food is protected. Bacon, soy sauce, salt pork, olives, and anchovies are all examples of foods preserved by salting. The term "corned beef" came from butchers' practices of covering meat in strong brine or coarse salt called corns to preserve the meat.

Sugaring also works by osmosis. Osmosis removes the water in jams, fruits in heavy sugar syrup, syrups, and sugared hams, among other foods.

Use a kitchen knife to slice whole pickles so that everyone can taste the *pickle seeds only*. Then slice fresh cucumbers so that each learner can taste the *cucumber seeds only*. Ask learners these questions:

What differences do you observe between the pickle and the cucumber? Learners will notice that a cucumber, much like water, is tasteless. Pickles taste salty and tart or vinegary. There may be a difference in texture too. Cucumbers may be more crisp than pickles. Most pickles are processed by heat to produce a vacuum in the jar. Heat makes pickles soggier and less crisp.

Did water flow into or out of the cucumber during the osmosis that turned it into a pickle? The water in the cucumber flowed out through the skin (semipermeable membrane) of the cucumber. It was replaced by the pickling solution (vinegar, salt, and spices).

If the cucumber was just sitting in water and sealed in a jar, would it be as safe to eat as a pickle? No. After several days, the cucumber in water would start to grow mold, bacteria, and possibly yeast. It would start to look slimy and have an unpleasant odor. It would definitely *not* be safe to eat a rotten cucumber. The pH of the cucumber is about 6. The pH of the water is about 7. These pH values are not low enough (acidic enough) to kill microorganisms, so the cucumber would start to rot.

Most pickle recipes specify that there should be at least as much vinegar as there is water. Why is this ratio important? It is important for the mixture of water and vinegar to be acidic enough to keep harmful microorganisms from growing. Recipes that do not contain as much vinegar as they do water are of questionable safety.

What are some advantages and disadvantages of pickling foods? Advantages include the following:

- Pickled foods keep for years in storage. They do not need to be refrigerated if they are sealed. This makes them easy and cheap to store at home.
- Pickled foods (cucumbers, peppers, and eggs, for example) are usually inexpensive. Pickling solutions are made of vinegar, salt, and spices, which are fairly cheap.
- Most people like either sweet or sour pickles. The tangy flavor of pickles is unlike most other foods.

Disadvantages include the following:

- Pickled foods always have to be kept in the pickling solution. The weight of this liquid makes the food containers heavy. The jars or containers can take up a lot of space. Backpackers don't usually carry pickled foods because they are too heavy and bulky.
- When you pickle foods, you use a vinegar or brine (salt) solution. These solutions can be flavored with other spices like dill, garlic, or sugar. But they will mostly taste like vinegar or salt. Foods that have little taste (cucumbers, peppers, eggs, etc.) take on the pickled favor very nicely. Most people, however, would not want to eat all pickled food. Pickled peanuts and pickled chicken might not be very popular.

Activity 3

Mold, Fungus, and Bacteria

Leader Notes

In this activity, learners observe microorganisms that grow on food samples. They explore how different methods of preservation affect microorganisms. To do this, they prepare boiled eggs in advance of this activity and store the eggs in a variety of ways. Learners use their eyes, nose, and a magnifying glass or microscope to explore microorganisms that grow on the boiled eggs. They record and analyze the data they gather. They learn about various organisms that can cause food to spoil. They make connections among microorganisms, food preservation techniques, and disinfection.

Key Questions

- What differences are visible in the eggs stored in water and those stored in vinegar?
- What differences are visible in the eggs stored in a refrigerator and those stored at room temperature?
- Of the six eggs, which is the safest to eat?
- Is storing hard-boiled eggs in the freezer a good way to preserve them?
- Where do the microorganisms that grow on the eggs come from?

Ten days before this activity, each learner needs to boil, peel, and store at least one egg in a certain way. Provide each learner with an egg and a copy of Handout 3-1, "Preparing Your Egg." On each person's handout, check which of the six storage methods the learner should use. Learners need to put boiled eggs in separate clear jars. Jars should be clearly labeled, and they should have lids that fit tightly.

If possible, assign at least two learners to use each storage method. That way, if some learners forget to bring their eggs for the next meeting, you will still have one of each

Materials Checklist

☐ Handout 3-1 (1 per learner)
☐ Handout 3-2 (1 per learner or group)
☐ Hand lens or microscopes (optional, 1 per 10 learners)
☐ If using a microscope:
  slides (flat and some with wells)
  slide covers (approximately 4 per learner)
  eyedroppers (7)
  distilled vinegar
☐ Pond water with mobile microorganisms in it (small amount)
☐ Copies of illustration of yeasts and molds/fungi (optional)
☐ Moldy bread (1 piece)
☐ Glass or acrylic jar with a tight lid (1 per learner)
☐ Eggs (1 per learner)
☐ Tap water

Approximate Time Required

30 minutes

Environmental Notes

Dispose of eggs and moldy bread where children or animals cannot get to them.

Recycle paper.

type. If learners will be boiling their eggs at home, provide containers so they can carry the raw eggs safely. Remind learners that you expect everyone to behave appropriately with the eggs.

When you meet again, learners should arrive with their boiled eggs in labeled jars. Allow them to look at all the different eggs, first with the naked eye and then with a magnifying glass. They should write their observations about each type of egg on Handout 3-2. Tell them to note smells and textures as well. You may or may not wish to have learners taste any eggs. If you do want them to taste the "safe" eggs, be careful to point out which eggs may be tasted.

Use a magnifying glass or a microscope to observe microorganisms in the liquid in which the eggs have been stored. (Microscopes provide more detail, but using them takes more time and makes the task more complex. Magnifying glasses are much simpler.) Gently shake the jars that have liquid in them. If you use microscopes, ask learners to use an eyedropper to place two or three drops of liquid on each slide. Cover it with a slide cover, and look at it under the microscope. Record observations on Handout 3-2.

To see other examples of microorganisms, learners could observe moldy bread and/or pond water under the magnifying glass or microscope.

Moldy bread often has a fuzzy, green growth on it. Have learners slice off a tiny part of the fuzz, place it on a slide (without a cover), and look at it under the hand lens or microscope. Have them record their observations.

Using an eyedropper, learners can place two or three drops of pond water on a slide, cover it with a slide cover. As they look at it under a hand lens or microscope, they can record their observations. Tell them to see what happens when they place one drop of pond water and one drop of distilled vinegar

What to Do in Advance

- ☐ Have learners prepare eggs 10 days or more in advance. Note: If some learners in your group do not live in situations where it is possible to prepare and keep an egg for 10 days, arrange to do this in your meeting room. You may need to provide eggs for learners.
- ☐ Set aside bread to begin molding two weeks in advance.
- ☐ Copy Handouts 3-1 and 3-2.

Safety Note

Learners should *not* taste eggs that have been stored (1) in tap water without refrigeration, (2) in tap water with refrigeration, OR (3) without liquid with refrigeration.

on a slide, jiggle them together, and cover them with a slide cover. Again, tell them to record their observations.

After the egg activity, go further into the world of microorganisms. "Leader Background Information: An Introduction to Microscopic Life" briefly tells about some of the mold, fungi, bacteria, and viruses most relevant to food safety. You might have learners research microorganisms such as these and develop creative ways to represent microorganisms and their role in food safety. Ask learners to discuss the following questions:

What differences are visible in the eggs stored in water and those stored in vinegar? Since vinegar is an acid, it should kill some microorganisms. This makes the egg safer to eat. The eggs stored in vinegar should show no signs of growth from microorganisms. The eggs stored in water should show some growth, visible either with or without a microscope.

What differences are visible in the eggs stored in a refrigerator and those stored at room temperature? Colder temperatures inhibit growth of microorganisms. The eggs stored in the refrigerator should show less growth than the eggs stored at room temperature without vinegar.

Of the six eggs, which should be the safest to eat? The safest to eat is the egg that is refrigerated in distilled vinegar. The combination of two methods of preservation/storage should help ensure safety. The egg in distilled vinegar without refrigeration is also OK to eat.

Do you think storing hard-boiled eggs in the freezer is a good way to preserve them? The texture of hard-boiled eggs changes after they thaw. Most people do not find this appetizing. But it would still be safe to eat the egg.

Activity 4

Dehydration

Leader Notes

Our prehistoric ancestors ate a diet made up mostly of plants. This was often supplemented by some meat, or by seafood if they lived near a shore. Their dependence on plants meant that many of the foods they ate were available only during certain seasons. Food preservation helped humans survive during the winter or other times when food was not plentiful. This is still true today.

There are five basic historical methods of food preservation: drying, heating, freezing, fermentation, and use of chemicals. Our ancestors did not know about microorganisms. But over generations, they tried out different ways to preserve foods. They learned that certain techniques, used alone or in combination, made foods last longer. Until very recently, craft knowledge of food preservation was an important part of most people's cultural knowledge. It affects economics, exploration, technology, and religion. For example, many religions include dietary taboos. These laws or warnings often have spiritual or cultural meanings. They could also protect people from bad food.

Dehydration is a preservation technique used around the world. Early in history, the Chinese and the Italians invented noodles and pastas. These starchy dry foods have a long shelf life. The Native American diet centered on corn and beans, preserved by drying, and squash. Many cultures preserved fruits and vegetables by drying. Until recently it was very common to see trays of fruit drying in front of the fireplace or wood stove. Apples were sliced into rings, strung on a broomstick or pole, and set in the sun or in front of the fireplace until dry. Trays of small berries were spread out to dry.

Drying, or dehydration, is popular because it is easy, reliable, cheap, and doesn't require

Materials Checklist

Making dehydrated food gifts

- ☐ Handout 4-1 (1 per learner)
- ☐ Food dehydrator (1 per group) (Note: Borrow a commercially built one for demonstration, or build your own. Directions for making your own are provided below.)
- ☐ Dehydrated fruits or vegetables
- ☐ Scales or balances for weighing fruit (approximately 1 per 12-15 learners)
- ☐ Wax paper (1 roll)
- ☐ Plastic gloves for food handling (at least 1 pair for each learner and adult)
- ☐ Small glass jars with lids (you may want learners to bring these from home) or small sealable bags (1 per learner)
- ☐ Calculators (approximately 1 per 12-15 learners)
- ☐ Large stainless steel bowl (1)
- ☐ Large spoon (1)
- ☐ Price sheet of fresh fruits and dehydrated fruits, listing either cost per ounce or cost per pound. List any fruits or vegetables you buy. If your group grows its own, compare what it costs to grow the food with what it costs at a local grocery store. (either 1 sheet, posted, or 1 sheet per learner)

Building a food dehydrator

Materials will vary with design; to build the design provided, these materials are needed:

- ☐ Aluminum roasting pans (2 of the one-use foil type, 16.5" x 13.5" x 3.25")
- ☐ Metal 16" x 10" baker's rack
- ☐ Lightbulb, socket (with switch), and cord or lamp-making kit
- ☐ Small aluminum loaf pan (the one-use foil type, 6" x 4")
- ☐ Binder clips (6, medium or large)
- ☐ Flexible wire (small pieces)
- ☐ Electrical tape (small amount)

expensive technology. Dried foods keep most of their nutrients, and they are easy to store and transport. Dehydration preserves food by removing water through heat and air movement. This slows the growth of microbes and cuts down on enzyme activity. The sun, an oven, or a dehydrating appliance—along with dry air—can aid dehydration. This allows foods that would have spoiled in days to be kept for a season or longer.

In this activity, learners explore the ancient technique of drying food, or dehydration. Learners will explore dehydrated foods, calculate what they cost, and build their own food dehydrator. They may also make dried food gifts or items to sell. They can use the dehydrator(s) they build to preserve food for an exhibition at the end of this project.

Key Questions

- What are the advantages and disadvantages of dehydrating foods?
- What are some types of foods that will not dehydrate well?
- Why are dried fruits and vegetables generally more expensive than fresh ones?
- Why is it no longer safe to dehydrate many raw meats to make jerky?

Learners may be familiar with a number of dry foods, including raisins, prunes, dried apples, and the ingredients of trail mixes. However, they might not immediately think of powdered milk, powdered eggs, dehydrated potatoes, powdered soup and sauce mixes, noodles, instant rice, jerky, and dry sausages as dried foods. Begin this activity by bringing in samples of dried foods. Or have learners locate dried foods in their homes.

This activity is flexible. Begin by letting learners taste, smell, and otherwise explore some dried foods. Have some fresh fruit available for comparison. Discuss smell, heat flow, and changes in appearance. Have

☐ Small piece of hose, pipe, or other conduit for protecting electrical cord where it travels through the loaf pan

☐ Knife (for making slits in pan and cutting hole for lightbulb)

☐ Battery-operated personal fan (less than 3" in height)

☐ Thermometer

Approximate Time Required

Tasting/exploring dried food, 20 minutes

Making dried food gifts, 20 minutes to put together, using previously dried fruits or vegetables

Dehydrating food, varies; using dehydrator design provided, plan on each dehydrator load taking overnight to dry

Building a food dehydrator, 45 minutes, using design provided

Designing and building your own food dehydrator, optional, 2-15 hours

Environmental Notes

Keep food sanitary so that it can be eaten.

Recycle leftover papers.

Keep homemade dehydrator for exhibition and use, or recycle parts appropriately. (That is, reuse clips, baking rack, lightbulb, socket, cord, and bottom roasting pan. Recycle the roasting pans used as a base and lid.)

What to Do in Advance

☐ Invite people who dehydrate food to talk with your group, or plan field trip(s).

☐ If possible, borrow a dehydrator for initial demonstration. If you are unable to borrow a dehydrator, your group will need to build one early in the activity.

☐ Decide when in the activity your group will build a dehydrator.

☐ Copy Handouts 4-1 and 4-2.

☐ Gather materials.

someone who dries food at home visit your class. This person can demonstrate techniques and tell stories about home food dehydrating.

Demonstrate how a home food dehydrator works. Then, have learners either build their own dehydrators to dry the food for the gifts or make dried food gifts before building a dehydrator.

If time allows, do research on the varieties and uses of dried foods around the world. Learners can get information from the Internet, library, ethnic marketplaces, and restaurants. If your group includes learners from diverse backgrounds, you may want to have a "Dried Foods Fair." They can share samples and recipes from their native cultures. Or, at the end of this project, your group could host an exhibition of dried foods. This exhibit could include a food-tasting table as well.

CAUTION

Safety Note

Drying is one of the safest methods of home food preservation. But mold and bacteria can grow in foods that are not dehydrated long enough. This can also happen if foods are stored in a container that has moisture in it. After water is added to dehydrated vegetables, the bacteria that cause botulism can grow. Use dehydrated foods promptly. Throw away any dried food that shows signs of spoilage or mold growth.

CAUTION

Safety Note

Before meats are dried at home, they must be preheated to destroy microorganisms. This is also true for some fruits and vegetables. Extreme care is necessary to safely dry meats. Do not experiment with drying meats in this activity. Many outbreaks of *E. coli* and other harmful microorganisms have resulted from home-dried beef or venison jerky. It used to be safer to dry meats, but changes in harmful microorganisms and their distribution mean that many recipes for jerky and dried meats that have been used for generations can now be deadly.

Exploring Dried Foods

Why are dried fruits and vegetables often more expensive than fresh fruits and vegetables? Dried fruits are more expensive because it takes more time, handling, and energy to remove the moisture. Extra equipment, energy, and packaging add to the cost of the product.

Which dried fruits surprise you most in appearance? Both bananas and grapes change quite a bit in appearance as they shrink. Learners will probably name other fruits as well.

What are the advantages and disadvantages of drying fruit? Dried fruits last longer without spoiling. They are easier to carry on hikes because they weigh less and take up less space than natural or canned fruit. Also, dried fruits are available year round. But there are some disadvantages. They cost more, and, of course, they lack moisture when they are eaten. Dried fruits also lose their fresh aroma, texture, and juiciness. They are usually darker, sweeter, and somewhat leathery compared to fresh fruits.

Making Dried Food Gifts

If learners make dried fruit or vegetable gifts, either provide them with a recipe or have them develop a recipe that is tasty and visually appealing.

Amounts vary depending on the size of the containers. Determine container size in advance. To reduce costs, use small containers. Dried vegetables are cheaper than dried fruits, unless your group dries its own fruits.

If you use dried fruits, use anything that can be dehydrated. These fruits work well: apples, bananas, peaches, mangos, pineapples, pears, prunes, raisins, pears, blueberries, cranberries, cherries, currants, and apricots. Citrus fruits, such as oranges and lemons, are often more difficult to dry.

If you wish to dry vegetables, these work well: peppers, tomatoes, carrots, onions, beans, green peas, black-eyed peas, okra, and beets. Many herbs also dry well.

Learners should use clean plastic gloves when they handle food. They should use scales to measure the amounts. They can decorate their jars or plastic bags by using ribbons, colorful fabric scraps, stickers, and bead strings.

Use Handout 4-1 to explore weight loss through loss of moisture. Have learners compare the prices of fresh and dried foods. Encourage learners to explore how they can make valid comparisons. Avoid immediately providing formulas.

Ask learners to calculate the cost of the dried fruits or vegetables in their gift, as well as the cost per pound of the food. If they want to sell dried food gifts, how much will they have to charge in order to earn a profit?

Building a Dehydrator

The climate in some parts of the world is hot and dry enough to dry foods outdoors. People there use hot rocks, metal, solar reflectors, ovens, or other ways to increase temperatures and protect the food from humidity. In other climates, a low-temperature oven or some type of dehydrator must be used to dry foods. A dehydrator is a device used to draw moisture out of food. Dehydrators generally use some type of heat (which could be solar heat), a fan (or other design for movement of air), and air vents. More complex dehydrators may use thermostats to keep an even temperature. They may use sophisticated methods to distribute air and remove moisture. Ordinary household ovens can be used to dehydrate fruits and vegetables if the thermostat can maintain temperatures as low as 140° F. There are even reports of using hatchback automobiles sitting in the summer sun as dehydrators.

If you are willing to experiment a lot, you can dehydrate foods in your oven by replacing the oven light with a stronger bulb. However, you cannot use the oven to cook while the higher wattage bulb is in place. The bulbs are not sturdy enough to withstand the oven's heat.

Our ancestors used a variety of materials and techniques to dry food. They used the materials at hand and processes that worked with their own climates and foods. They developed technology and procedures that allowed them to produce a safe supply of dried foods. For example, in the southwestern United States, people can sometimes dry food outdoors by simply hanging the food up or setting it out in thin layers. This is because of the high temperatures and dry climate.

You may wish to start by having learners interview older people in the community to ask if they dried food when they were younger and how they did it. Talk with gardeners, orchard owners, and others who might dry fruits and vegetables. If there is a company nearby that dries fruits or vegetables, take a field trip or invite a speaker to talk to your group.

In general, herbs and flowers should be dried at temperatures around 100° F to 110° F. Fruits and vegetables should be dried at temperatures from 130° F to 140° F.[1] If the temperature is too low, the food may spoil instead of dry. If the temperature is too high, the surface of the food may harden and prevent moisture from escaping. It will cook on the outside, forming a crust or glaze that traps moisture inside. Learners should keep this in mind as they design a food dehydrator that can dry small amounts of fruits and vegetables.

A dehydrator should bring and maintain food to proper temperatures, and provide for movement of air and removal of moisture. It should be safe to build and operate. It should require few materials, and it should be inexpensive. Many designs are possible. Provided here are step-by-step instructions on how to build one simple home dehydrator. You can build this dehydrator with your group. Or learners can develop their own designs.

Handout 4-2 includes a sample design that can be put together in a few minutes with materials from the grocery store. Materials will vary depending on the designs the learners develop. You should use a sturdy thermometer to monitor temperatures. Meat or candy thermometers work well.

If learners design their own dehydrators, they should form design teams—small groups that work together to brainstorm and develop a design. Design teams should then present their ideas to the entire group for feedback and suggestions. All should consider whether the design will work, how safe and easy it is to use, and how much it costs. They should write down their plans on Handout 4-3. One or more designs should be selected to modify and build.

CAUTION

Safety Note

If learners design their own dehydrators, it is important to look at their designs carefully. How safe are the materials, construction processes, and the finished product? Are there sharp edges that could cut? Heating components that could burn? Potential electrical hazards? If cutting holes, hammering, or other issues are safety concerns for those in your group, have an adult perform or supervise these activities.

Activity 5

Canning, Pressure Cooking, and Air Pressure

Leader Notes

Canning

Home canning is one of the most popular and cost-effective ways to preserve food. The process was developed in competition for a prize established by Napoleon to provide better foods for his army. It is now used at home by millions who want to preserve the bounty of their gardens and orchards. In this activity, learners explore the science and technology of home canning. They address concepts of heat, temperature, pressure, and microorganisms. They taste the difference between pressure cooking and stove-top cooking, crush cans with air pressure, listen to the rush of air into a can of food when it is opened, and sample a variety of canned foods. This activity should help learners better understand pressure, temperature, heat, and the whys and hows of canning food as a means of preservation.

Key Questions

- What are some of the advantages and disadvantages of home canning?
- Why are glass jars used in home canning?
- How does the pressure regulator regulate the pressure in a cooker?
- Why does the pressure cooker need to have a pressure gauge for home canning?
- Does a pressure cooker need to be sterilized when used for home canning?
- Why must some foods be canned in a pressure cooker while other foods do not have to be pressure canned?
- Why are some home canning recipes that were safe 50 years ago no longer safe?

Materials Checklist

- ☐ Pressure cooker with pressure gauge and lid (Make sure to use a modern pressure cooker with a safety valve.)
- ☐ 4 to 5 pounds of dried pinto beans (1 batch pressure-cooked for 30 minutes; 1 batch simmered without pressure for 30 minutes)
- ☐ Small bowls and spoons (1 for each learner)
- ☐ Large serving spoon
- ☐ Napkins or clean rags
- ☐ Plastic gloves for food handling
- ☐ Home canning supplies for demonstration: racks, jars of various sizes, lids with seals and rings
- ☐ Samples of previously canned foods
- ☐ Can opener
- ☐ Blindfold
- ☐ Tongs
- ☐ Ice
- ☐ Aluminum pop cans (empty; at least 1 per learner)
- ☐ Hot plate or burner
- ☐ Large tongs

Approximate Time Required

Presentation by home canner and/or extension agent, time varies

Canning technology demonstration, 20 minutes

Tasting beans, 20 minutes

Crushing cans, 20 minutes

Research on canning, time varies

Canning is the process of preserving food by

- putting the food in an airtight, sealable container
- applying heat to destroy microorganisms and inactivate enzymes
- removing air from the jar by heating
- sealing the jar to keep microorganisms out
- cooling the jar to create a lower pressure inside the jar

Environmental Notes

Wash rags for reuse.

Put any leftover beans on compost pile.

Recycle pop cans.

Dispose of plastic gloves in trash.

What to Do in Advance

☐ Arrange a visit by a home canner and/or field trips to canning facilities.

☐ Depending upon your facilities, you may need to prepare beans in advance.

The heat comes from a boiling water bath or pressure canner. In general, canning involves cooking food, then putting it in clean hot jars along with the liquid it was cooked in. The jar is heated to drive out most of the air. (The amount of time needed to heat the jars depends on what is being preserved. For example, meat takes longer than vegetables.) The mouth of the jar is covered with a flat disk that has a rubber seal around it and a screw top to hold the disk in place. When the jar and food cool, the pressure inside the can decreases and the jar is sealed. Jams and jellies, often canned at home, use a variant of this procedure. Their high sugar content serves as a preservative.

pH, which learners explored in Activity Two, is a critical factor in home canning. High acidity foods (low pH) can be canned in a boiling water bath. Acidity, in conjunction with heat from the water bath and sealing, is sufficient to kill off undesirable microorganisms and to disable enzymes. However, relatively low acidity (relatively high pH) foods must be pressure canned. Pressure canning allows foods to be heated to a considerably higher temperature than is possible at room pressure. In the context of home canning, a pH below 4.6 is generally safe for boiling water canning; a pH above 4.6 requires pressure canning. The organism that causes botulism is of extreme concern in canned foods because it thrives in the low-oxygen (relatively anaerobic) environment of canned foods.

As we develop or use different varieties of fruits and vegetables, their pH can change. Many years ago, most homegrown tomatoes were fairly acidic. Their acidity generally made them safe to can without using a pressure canner. As lower-acidity (higher pH or more basic) tomatoes were developed and came into common use, it was no longer safe to assume that tomatoes could be canned without using a pressure cooker. Older recipes that don't use pressure canning may now be dangerous.

The pH level is not the sole factor in how, or whether, a food should be preserved by canning. Heat transfer is another important issue. Some food items, because of their density, clumping, or other packing properties, can't reliably get hot enough in the middle of the jar to can at home safely.[34]

A study of home canning provides opportunities for learners to combine their understandings of microbiology and chemistry with the physics of heat, temperature, and pressure, and their experiences with traditional food preservation practices. Canning appeals to chefs, physicists, farmers, and engineers—and involves content from all these areas. Invite home canners to speak to your group about why and what they can. Visit a cannery. Invite an extension agent to discuss home canning in your community and the latest techniques for home canning. Encourage learners to do research into the reasons why we have developed different varieties of tomatoes—and the implications of some of these changes for the way tomatoes have to be canned. Explore the economic and political impacts of canning on life in the eighteenth and nineteenth centuries. If age-appropriate, encourage learners to read *Cannery Row*, and do research on the economic and human impacts in the area when the fisheries became exhausted and the canneries closed. Do a study of what foods from your region were traditionally preserved through canning. If time and resources allow, do some canning in your group meeting or classroom.

Begin this activity with a kitchen or grocery survey of foods preserved by canning. Or ask learners to bring in a sample or list of canned foods commonly used by their families.

Ask learners to observe and describe the sounds and smells as you open a metal can of vegetables, using a can opener. Then, open a glass jar of home-canned food and a jar of pickles that were canned commercially. Ask them to explain the noise they heard as they opened the cans. (Most should relate it as a rush of air from "breaking the vacuum.") Ask learners whether the air is rushing into the container or out of the container and why the question is important.

The "rush" of air heard when the container is opened is air moving into the container. When food is processed, boiling causes much of the air to be forced out of the container. When the air is forced out and the jar cools, the rubber seal (in home canning) closes tightly, creating a lower pressure inside the jar. This is important because many organisms cannot grow in the food without air. When the container is opened, air rushes in quickly to equalize the pressure.

Display home canning equipment (empty canning jars, lids, rings, pressure cooker, and previously canned foods). Briefly explain techniques as a prelude to further exploration. Your explanation should address the fact that some foods must be canned in a pressure canner, whereas other foods, of lower pH, can be canned at room pressure.

If you have access to a stove in your meeting room, cook pinto beans for the next part of the activity during your meeting. If not, you can cook

CAUTION

Safety Note

Some older pressure cookers do not have a safety valve. These pressure cookers can explode. All modern pressure cookers have a safety plug that prevents explosions. Do not use a pressure cooker that does not have a safety valve!

the beans in advance of the meeting. Cook two pots of beans for 30 minutes. One pot should be simmered in an open kettle on the stove top. The other pot should be simmered in a pressure cooker.

Blindfold learners (one at a time) and ask them to taste the beans. They should decide which beans were cooked in the pressure cooker and which were cooked by simmering. Explain that the beans in the pressure cooker were more thoroughly cooked because the higher temperature allowed water to boil at a higher pressure. Display the parts of a pressure cooker and explain that a pressure cooker is essentially a saucepan with an airtight lid, a pressure vent, and a safety valve. When the pressure vent is closed and the lid is on tight, water heats to boiling and generates steam. The vapor is confined in the pan and the pressure inside the pot increases. Whereas at atmospheric pressure water boils at 100° C (212° F), at higher pressures water boils at higher temperatures. For example, at five pounds pressure, the boiling point of water is 109° C. In a typical pressure cooker, water can reach temperatures as high as 120° C at 15 pounds of pressure. (15 pounds of pressure on the pressure gauge is approximately 2 atmospheres total of pressure.)

If age-appropriate, ask learners to use their knowledge of heat, temperature, energy, and pressure to develop a model of what is happening inside the pressure cooker in terms of molecules and their movement.

Point out that pressure canners have a gauge to monitor pressure and that temperature control is another method used to maintain proper pressure. All modern pressure cookers have a safety valve that blows out of the lid if the pressure goes above a preset point.

Ask learners to explain why pressure cooking is necessary when home canning some vegetables and meats. Have them discuss the role of the rubber rings on the pressure cooker lid, as well as on home canning lids.

How does the pressure regulator regulate the pressure in the cooker? The regulator controls the pressure in the cooker by trapping the steam inside. When too much pressure builds inside, a valve allows some steam to escape and the pressure goes down. Another way of reducing the pressure inside the cooker is by reducing the amount of heat at the heat source (the burner on the stove).

Why are glass jars used in home canning? In the 1800s John Mason invented the glass canning jar, which we still call the "Mason jar." This type of container is still best for home canning because it is affordable, reusable, and can be sterilized. Also, with the use of rubber-ringed lids, glass jars allow a lower pressure to be created when heat is applied. Finally, when glass jars are used, the food can be seen, which makes it easier to notice changes in the color or condition of the canned food.

Why does the pressure cooker need to have a pressure gauge for home canning? The cooker needs a pressure gauge to regulate the pressure and, therefore, the temperature of foods being canned. The heat prevents food spoilage. Regulating the pressure prevents damage to the glass jars inside the pressure cooker. Also, various foods require different amounts of heat and pressure.

Do we need to sterilize when a pressure cooker is used for canning? If foods are canned in a pressure cooker and they boil less than 10 minutes, it is still best to sterilize the jars in order to prevent growth of harmful organisms in the food. However, if the boiling in the pressure cooker exceeds 10 minutes, it is not necessary to sterilize since the length of boiling time, and the temperature reached (240°-250° F), would safeguard the food from spoilage, as harmful bacteria and germs could not survive these conditions.

Why must some foods be canned in the pressure cooker but not other foods? Pressure cooker canning is not necessary for all foods. Foods with a high acid content do not allow bacteria to grow in them as easily as low acidity foods. Therefore, high acidity foods can be safely canned in water that reaches only 212° F. However, since bacteria grows more easily in low acidity foods, such as fish, poultry, and some vegetables, it is necessary to process them in a pressure cooker where temperatures reach as high as 240°-250° F.

Collapsing Cans

Atmospheric pressure can be difficult for young people to recognize. This activity demonstrates the existence of air pressure by exploring its effects on a can in which the pressure has been lowered. Heating a small amount of water in a 12-ounce pop can, then rapidly cooling the can, provides a delightful visual and audible experience in air pressure and heat—one that you can directly relate to the canning process.

Allow at least one empty aluminum pop can for each learner (more if possible) for this addictive activity. Put 1/4 to 1/2 inch of water in each can.

Heat the can of water to a boil. Continue heating until a cloud of water vapor comes out of the can for about 20 seconds. Heating expels air from the can, just like heating jars of food in a water bath expels air from the food jars.

Using tongs *(cans will be extremely hot—do not use your bare hands)* quickly lift the can from the burner and invert it into the cold water. (A tray with high sides or a large bowl work well for holding the cold water. There should be two to three inches of cold water in the bowl or tray.)

The can cools rapidly and is crushed instantly as the water vapor condenses, reducing the pressure inside the can. The difference between the greater air pressure outside the can and the reduced pressure inside the can pushes the sides of the can inward.

Learners may note that the cans contain small amounts of water after crushing. It is this water, which is drawn up into the can, that causes the steam to condense so rapidly.

Empty water out of the cans before taking them for recycling.

CAUTION

Safety Note

The can contains boiling water and can cause burns. The hot plate or burner can also cause burns. Monitor this activity carefully. You may want to do the activity as a demonstration for younger learners.

Activity 6

Refrigerating and Freezing Foods

Leader Notes

While learners may think of refrigeration and freezing as hallmarks of the modern world, our ancient ancestors who lived in areas with cold winters and/or cold caves used these techniques. They stored mammoth meat in icy waters and used cool areas of caves to refrigerate their food. Winter ice has been stored and used for hundreds of years—and has been available commercially since at least 1820. It wasn't until the 1940s, however, that modern refrigeration technology became low enough in cost for home refrigeration and freezing to take off. Now, in areas with reliable electrical service, freezing and refrigerating are two of the easiest, most convenient, and least-time consuming methods of preserving foods. Freezing is simple to do, and it keeps many foods closer to fresh taste, texture, and nutritional value than many other methods. The main disadvantages of freezing and refrigerating concern the costs of purchasing and maintaining the freezer and the need for reliable electrical service.

Key Questions

- How does freezing work as a method of food preservation?
- What is freezer burn?
- What are some ways of freezing and refrigerating food without a refrigerator?

Refrigeration involves chilling and storing food at 0° C to 4° C. In the freezing process, water in foods is turned into ice and becomes unavailable for microorganisms to grow and for enzymes to work (as in dehydration). Foods are frozen to approximately -20° C. Freezing doesn't sterilize foods or kill microorganisms, it just retards microorganism growth. Frozen food is safe as long as it

Materials Checklist

- ☐ Handouts 6-1 and 6-2 (1 per learner; Handout 6-2 is optional)
- ☐ Freezer wrap (white paper)
- ☐ Plastic wrap
- ☐ Wax paper
- ☐ Aluminum foil
- ☐ Plastic baggies
- ☐ Fasteners—tape, rubber bands, twist ties
- ☐ Marker pen
- ☐ Storage containers:
  - plastic containers and lids
  - glass jars and lids
  - ceramic bowls and plastic wrap
  - plastic bags
- ☐ Straws
- ☐ Netting bags of chopped onions (1 per learner)
- ☐ Leftover foods (several types) (Note: To avoid waste and lessen transportation problems, you may want to use pictures or descriptions rather than actual food items.)

Approximate Time Required

Wrapping food and discussion, 30 minutes

Developing tip sheets, 45 minutes

Environmental Notes

Dispose of onions on compost pile.

Recycle leftover paper and aluminum foil when possible.

stays frozen but should be thawed in a refrigerator to minimize growth of microorganisms.

When water freezes, it expands. Ice crystals cause cell walls in food to rupture, changing the texture of the food when it thaws. The loss of moisture causes another problem called freezer burn. Ice crystals evaporate from the surface of the food, producing dry, tough, grainy areas that may not have a good taste. Freezer burn doesn't cause illness, but it does cause some wasting of food. To minimize freezer burn, wrap food in heavy, moisture-resistant, odorless, tasteless, durable, and leakproof wrap for freezing.

Freeze-drying is a special form of freezing. Food is very quickly frozen at very low temperatures and at very low pressure. Freeze drying removes about 98 percent of the moisture from food and allows it to be stored without freezing.

This simple activity engages learners in an examination of how freezer burn happens and how best to prevent it. Handout 6-1 provides directions. Using onions as a stand-in for food to be frozen, they experiment with various methods of wrapping the onions. Then they relate their results to freezer burn. They also choose proper storage containers for various food items and develop and compare tip sheets for refrigerating and freezing foods.

You can use Handout 6-2 for your own information as a comparison sheet for learner checklists, or you can hand it out. *Do not give it out before learners develop their own sheets.*

What to Do in Advance

- ☐ Copy Handouts 6-1 and 6-2 (6-2 is optional).
- ☐ You may want to chop onions in advance as a safety precaution.
- ☐ You can also purchase frozen, chopped onions.

Activity 7

Can You Find the Food Additives?

Leader Notes

Some consumers think chemical food additives are recent and artificial additions to our food, but chemical additives have actually been used for hundreds of years. For example, documented use of nitrates goes back to medieval times. The use of salt goes back to prehistory. Salt was so important to our ancestors that in some areas workers were paid in salt. Our word salary comes from *sal*, the Latin term for salt. The phrase "worth one's salt" is another example of how important this chemical was to society.

Not all additives are synthetic. Foods that naturally contain antimicrobial agents include garlic; onion; leeks; spices such as cinnamon, cloves, and allspice; olives and olive oil; and the caffeine in coffee, tea, cola, and cocoa. Potatoes, peppers, carrots, and grapes produce natural antimicrobials when they are invaded by microbes.[35]

Key Questions

- What are the advantages and disadvantages of using food additives?
- Are additives present in large or small amounts in the food you eat?
- Do chemical preservatives affect food in any way other than preservation?
- Do any additives have potentially harmful side effects?
- How do you think food additives are discovered?
- Would you be willing to limit your diet to only locally grown and in-season foods to avoid chemical preservatives?

Chemical additives are widely used because they can

- improve or maintain the nutritional value of food, for example, through adding or restor-

Materials Checklist

☐ Handout 7-1 (1 or more per learner)

☐ Handout 7-2 (optional, 1 per learner)

☐ Handout 7-3 (optional, 1 per learner)
Laundry basket of common processed foods (empty packages and cans are fine)

☐ Additional resources on food additives and potential side effects (Note: Useful books on food additives include *The Food Additives Book*, Nicholas Freydberg and Willis A. Gortner, 1982; *A Consumer's Dictionary of Food Additives*, Ruth Winter, 1994; *Food Additives: A Shopper's Guide To What's Safe & What's Not*, Christine H. Farlow, 1997; *Additives (Food Facts)*, Rhoda Nottridge, 1993; and medical guidebooks.)

☐ Access to Internet sites including these: U.S. Food and Drug Administration, Center for Food Safety & Applied Nutrition—http://vm.cfsan.fda.gov/~dms/opa-bckg.html

Gateway to Government Food Safety Information—http://www.foodsafety.gov/

National Agricultural Library Food Safety Index—http://www.nal.usda.gov/fnic/foodborne/fbindex/index.htm

Institute of Food Science & Technology(UK)—http://www.easynet.co.uk/ifst/ifstfaq3.htm

Approximate Time Required

Food Additive Hunt, 20 minutes

Research on food additives, 40 minutes to 2 hours

Environmental Note

Recycle leftover paper.

ing vitamins and minerals to processed foods

- enhance the quality and safety of some food products
- increase shelf life, prevent spoilage, and reduce waste
- enable people to ship foods to other geographic locations
- make foods look better so that people will buy them
- make food preparation more convenient

What to Do in Advance

☐ Collect labels and/or have learners bring in labels.

☐ Gather reference materials or arrange Web access. (You might want to hold your group meeting in a library for this session.)

☐ Copy Handouts 7-1 to 7-3.

<Definition

BHA, or butylated hydroxyanisole, and **BHT**, or butylated hydroxytoluene, are chemicals that are added to food in small quantities as preservatives. BHA and BHT are antioxidants. Antioxidants are chemicals that inhibit the process of reactions due to oxygen. A food-based example of oxidation is the browning that happens when you cut up an apple into pieces. You can use lemon juice to slow down the browning. The lemon juice acts as an antioxidant.

There are three general classes of common preservatives, benzoates, nitrates, and sulfites. *Benzoates*, such as sodium benzoate, are used to inhibit mold. Benzoates are used as preservatives in foods such as cheese, some beverages, sauces, and condiments. *Nitrates*, such as sodium nitrite when used in combination with salt, are antimicrobials. Nitrates inhibit botulism in meats, act as preservatives, provide flavoring, and fix colors. At high temperatures, in some meats such as bacon, nitrates can be converted to nitrosamines, a carcinogenic class of chemicals. Nitrosamines can concentrate in bacon grease, and you should think twice about cooking with bacon grease for this reason.[36] *Sulfites*, including sulfur dioxide, sodium sulfite, and sodium and potassium bisulfite, are antioxidants. Antioxidants reduce discoloration in fruits, vegetables, and bleach, and they disinfect dried foods. Sulfites are also used in wine making. Some people are sensitive to sulfites and have a strong, occasionally fatal, reaction to the chemicals.

BHA and *BHT* are preservatives familiar to those who eat snack foods such as potato chips and cheese balls. BHA and BHT are used in foods that are high in fats and oils. (They are also used in dry foods.) BHA and BHT slow the development of off-flavors and odors, prevent color changes, slow deterioration, and protect fat-soluble vitamins.

In this activity learners research some common processed foods to find out what chemical preservatives they include, and investigate the literature (either print or electronic) on preservatives to discover potential side effects of the preservatives.

Supply a variety of common food items (empty boxes and cans or labels are OK). Learners should take two or more packages of food from the basket and read the ingredients. On Handout 7-1, record the ingredients that sound like they might be chemical preservatives.

Most additives are used in small quantities. Ingredients listed on the packages of foods are listed in descending order of quantity, therefore, food additives will usually be listed near the end of the list.

Handout 7-2 provides a list of some common food items and common preservatives or additives. You may want to use this handout to provide learners with examples of the types of substances to search for on the labels.

Use Handout 7-3 or resource books to look up the chemical to find its function. Resource books will provide more detailed information. Handout 7-3 is a more general discussion of the functions of various types of additives.

Estimate the amount of chemical preservatives you think has been added to each package of food. Usually the preservatives are in the form of a powder or crystals, and they are added in very small amounts, less than one gram/serving (smaller than a raisin). Some additives are used only in milligram (0.001 grams) amounts. Compare the position of the additive on the ingredient list to that of other items listed on the label to make an estimate. (The position of the item in the list is related to the amount of the item in the food. The more of an ingredient there is in a food, the earlier it will be found in the ingredient list. Items near the end of the list are present in small amounts.)

Do chemical preservatives affect food in any way other than preservation? Most preservatives go through years of research and chemical and biological studies. They are refined so that they generally do not have substantial negative effects on the food. Additives may change texture or color. However, some people are particularly sensitive to some additives. For these people, generally safe additives can be dangerous. Also, any scientific knowledge is subject to change, as more data come in and our thinking is revised and elaborated.

Do any of the additives have potentially harmful side effects? Some food additives cause problems in a few sensitive people. These problems can be severe, however, and include death, *anaphylactic shock*, difficulty in breathing, rashes, headaches, and nausea.

How do you think chemical preservatives are discovered? Many older preservatives were discovered by observation and experimentation hundreds of years ago. Many newer preservatives are compounds similar in composition to those used in ancient times. Others are the result of modern research efforts. For example, when BHA was found to be a useful preservative, chemists investigated other chemicals with similar compositions. BHT, a similar compound, has similar preservative properties.

Would you be willing to limit your diet to only locally grown and in-season foods to avoid chemical preservatives? Responses will vary.

Definition

Anaphylactic shock is a severe and potentially life-threatening allergic reaction throughout the entire body. It occurs when an allergen enters the bloodstream and circulates through the entire body.

Activity 8

Fermentation—What a Cheesy Idea!

Leader Notes

Key Questions

- Why can the process of making bread, cheese, yogurt, kim chee, pretzels, and sauerkraut be considered to be microbiology?
- How are beneficial microbes used in fermentation?
- Why is it important to heat the milk to 161° F before adding other ingredients prior to making yogurt?
- Why do you add already-made yogurt to yogurt that you are making?
- Why is it necessary for yogurt to incubate?
- How does fermentation make bread rise?

Legends, lore, and local traditions surround fermentation, another ancient food preservation technique. For example, yogurt and cheese supposedly originated in the Middle East when a Bedouin made a long journey on camel across the desert, carrying only a goatskin pouch of milk for sustenance. At the end of the day, the thirsty traveler opened the pouch, expecting a refreshing sip of milk. Instead, the pouch contained a thick white mass and thin fluid. With nothing else to drink, the dismayed traveler drank the liquid and found it refreshing. Tasting the mass, which we now call curds, proved enlightening as well. They tasted good and were highly edible. What we now consider to be four major needs of cheese making (heat, motion, time, and reaction with particular enzymes) were present in that jostling goatskin pouch, producing the curds and the liquid, which we call whey. According to the legend, worldwide industries were born from this accident of travel. While estimates vary widely, most recent sources agree that cheese and yogurt have been produced for more than 9,000 years.

Materials Checklist

Capturing wild yeast

- ☐ Glass jars (1 per learner—have learners bring these from home)
- ☐ Pieces of old stocking material (1 pair of old panty hose should make enough lids for a fairly large group of learners)
- ☐ Rubber bands (1 per learner)
- ☐ Flour (plan on 1 cup per learner to catch yeast; 1 cup per learner to feed yeast)
- ☐ Water
- ☐ Measuring cup (to measure flour and water)

Making yogurt

- ☐ Milk (1/2 cup per learner or team)
- ☐ Measuring cup to measure milk (1 per learner or team)
- ☐ Plain commercial yogurt with active cultures (Note: The yogurt should not contain gelatin, read the label carefully!) (1 carton per learner or team)
- ☐ Saucepans for heating milk (1 per team, or teams can share)
- ☐ Stirring spoons (1 per learner or team)
- ☐ Stove or other heat source for heating milk
- ☐ Thermometers for monitoring temperature—candy thermometers work well (1 per learner or team)
- ☐ Method for incubating yogurt (commercial yogurt maker, thermos bottle, oven and glass jars, Crock-Pot®)
- ☐ Spoons for tasting (1 per learner)

Fermented beverages such as wine have played important roles throughout history. They were widely consumed in many of the earliest civilizations because they were safer to drink than water. In ancient cities, sanitation was a major problem. Waste was often disposed of by dumping it outside, which contaminated the water supply. Cleanliness standards were quite different. Water often harbored deadly germs and parasites. It is little wonder that fermented beverages were so important that some cultures, such as the Greeks and the Romans, had gods of fermented beverages.

In Korea, kim chee, a fermented cabbage dish, has been named a national treasure. Kim chee is made by pickling Chinese cabbage with garlic, salt, and red peppers. The product is high in vitamins B and C and served as an important source of these vitamins throughout the winter for thousands of years. During the winter, kim chee was buried to keep it from freezing, thus it is sometimes still called buried cabbage.

Many ancient sausages were fermented for preservation. Sausage makers mixed fresh pork with seasoning and salt, then packed it in animal skins and put it away to dry and age. The combination of fermentation, drying, and antimicrobial additives meant that sausages could be eaten months after the animal was slaughtered. Sausage making was so important to food supplies around the world that it is mentioned repeatedly in early writings, such as the *Odyssey*. The tangy flavor of pepperoni is caused by fermentation. Preservation processes of local cultures gave distinctive flavors to many sausages, and numerous cities were named for the sausages made there or vice versa. Salami originated in Salimas; the city of Bologna produced a characteristic sausage called bologna; the frankfurter came from Frankfurt.

Bread is also a product of fermentation, as are crackers, doughnuts, buttermilk, sour cream, soy sauce, wines, cheeses, coffees, and

Approximate Time Required

Presentation by sourdough bread maker, yogurt maker, etc., and/or field trip, time varies

Capturing wild yeast: preparation and observation, 15 minutes; sitting time, 3-5 days minimum

Making yogurt: preparation, 30 minutes; incubation, 4-8 hours

Baking bread (optional): mixing, 15 minutes; rising and baking, 2-4 hours

Research on fermentation, 1-3 hours

Environmental Notes

Keep yogurt sanitary so that it can be eaten.

Bake bread with wild yeast.

Old stocking material can be washed and reused or discarded in trash.

Recycle leftover paper.

What to Do in Advance

- ☐ Plan so that yeast capture can take place in sufficiently warm weather.
- ☐ Decide how you will incubate the yogurt.
- ☐ Gather materials.
- ☐ Copy Handout 8-1.
- ☐ Bring in, or have learners bring in, samples of fermented foods.
- ☐ Select basic bread recipe and make arrangements for baking bread with wild yeast (optional).

teas. Sauerkraut gets its tang from the fermentation process. Fermentation also provides root beer with its bubbles and pickles with their bite. Some vinegar is produced by fermenting wine, which is already a fermented beverage.

There are hundreds of varieties of cheese throughout the world. Microorganisms provide cheese varieties with particular flavors and aromas. The types of microorganisms present vary with climate. For example, in the Middle East most cheeses are made with thermophilic or "warmth-loving" bacteria that thrive at temperatures around 44° C. Cheeses from colder regions often use mesophilic "moderate temperature-loving" bacteria that thrive around 37° C.[37] By the Middle Ages many regions produced cheeses with distinctive characteristics. Many of the cheeses we eat today are simple variations on these ancient cheeses. Before refrigeration was widely available, cheeses that were particularly salty and particularly acidic were favored because they kept well. Feta cheese, popular today, is one such cheese that has probably changed little from its ancient roots.

While this practical microbiology has been in use since prehistoric times, it was not until the nineteenth century that we developed an understanding of the role of microorganisms in fermentation. The modern view of fermentation is one of using beneficial bacteria and yeasts to produce products that prevent harmful bacteria from spoiling food. Beneficial bacteria digest sugars and starches, converting them to acids, ethyl alcohol, and carbon dioxide. These changes, caused by enzymes in the bacteria, yeasts, and mold, are essentially the result of a microbial infection, an infection that makes foods last longer or taste better. The alcohol and acids produced inhibit the growth of other bacteria in the food.

Fresh milk is often called sweet milk because it tastes sweet. The sweetness comes from lactose or milk sugar. When milk is fermented, bacteria digest the lactose and convert it into lactic acid. The process also produces carbon dioxide. Soured milk tastes sharp, fruity, or bitter because the lactose has been digested. Clabbered milk is a thickening caused by such fermentation. The enzyme rennin, found in the lining of some animal stomachs as well as from other sources, speeds up curdling and is used in cheese making.

Vegetables and vegetable products such as sauerkraut, pickles, and kim chee, are often fermented by packing them tightly in a container and covering them with salt or brine. The salt promotes the growth of lactic-acid-producing bacteria. The lactic acid lowers the pH enough to prevent harmful bacteria from growing and lowers the activity of enzymes that would cause the foods to spoil.

When baking bread, yeasts act as tiny fermentation factories producing carbon dioxide and alcohol. The sharp odor you smell when bread is breaking is ethyl alcohol produced by the yeast. When you knead dough, you are facilitating the work of the yeast by creating air pockets to be filled with gas during the leavening process. As gases rise during fermentation, the dough lifts up to produce an airy loaf.

Fermentation is an anaerobic activity (proceeding without oxygen). Many examples of fermentation involve covering vegetables or milk products with liquid to keep out air.

In this activity, learners will explore fermentation in two ways—through capturing their own wild yeast strains and by making yogurt. Capturing wild yeast strains illustrates to learners that yeasts are all about us. It also provides wonderful opportunities for experimenting with the properties of yeasts captured in different locations and may be a source of numerous science or social studies fair projects. (Your yeast may taste yucky, or it may spark a boom in your region as the home of a tasty new bread—or anything in between!)

Through the yogurt-making process, learners do hands-on microbiology. Yogurt recipes embody an incredible amount of microbiology—as well as produce a tasty product. It is important to point out the many career areas that are microbiology related—biologists, food scientists, engineers, chefs, yogurt-store managers, food inspectors, etc. The yogurt-making process also provides ample opportunities for experimentation and may be easily extended to science or social studies fair activities.

This activity is written in two parts. Because outdoor temperature is important to capturing and growing wild yeast, plan the way you structure the activity around the weather. You may want to start the wild yeast capture process, then proceed to yogurt making. You can then come back to the wild yeast and bread baking. Or, you may want to do yogurt making first.

Because fermentation is not as obvious a preservation method as canning or freezing, learners may not have enough information to do a preactivity survey of their kitchens. Instead, depending on your community, you may wish to begin by bringing in people who make their own pickles, sausage, cheese, bread, sauerkraut, or kim chee. You may want to take learners on a field trip to a bakery, cheese factory, or milk processing plant. Learners could also take a survey of older adults and of young people to find out how many in each group have eaten yogurt, or ate it regularly as a child. Taste a variety of pickles, yogurts, cheeses, or breads and ask learners what factors they believe are responsible for the differences in taste.

Learners should be able to give a brief overview of the fermentation process. They should develop an appreciation for the role fermentation has played in history, and an awareness of fermented foods they eat today.

Capturing Wild Yeast

People who bake sourdough bread often set great store by the particular strain of yeast they use. If they like the taste of a strain, they may keep it growing for years. You can experiment with yeasts and their properties by capturing some yeasts from your backyard or school yard. In capturing the yeast, you are using a process similar to that used by bakers to keep their sourdough "starters" growing.

An ideal temperature for this activity is 60° F or above. If the temperature is between 35° F and 60° F, you may not see evidence of capture until the yeast has been brought inside and allowed to warm up for several hours. If the temperature is less than 35° F you are likely to have little success with this activity.

Make a mixture of equal amounts of flour and water. Put the mix in a clean glass jar. Cover the jar with a piece of clean, nylon panty hose. Fasten the panty hose to the jar with a rubber band. The panty hose will let air and microorganisms into the jar but keep insects out. Put the jar in a place where it will not be disturbed, and let it sit outside for three to five days.

Bring the jar inside to check for evidence of yeast. If yeast is present and growing, you should see lots of bubbles. If the mixture has lots of bubbles, you can feed the yeast. Do so by adding more of the flour/water mixture and letting it ferment overnight. Then use the mixture to make bread. If the mixture does not have numerous bubbles, throw out your flour and water mix and start again.

You may want to have a basic bread recipe available for learners, or they can look at recipe books or search the Internet.

Yogurt—An Ancient Food Goes Modern

Yogurt has been important in many parts of the world since before recorded history. It is considered a staple in the Middle East. In India it is used to quell the burning from hot spices. However, yogurt has become popular in the United States only in the last few decades. The widespread recognition of the harmful effects of eating too much fat, together with a greater multicultural influence on the American diet, and the rise of frozen yogurt as a treat have made yogurt an important food item.

The process for making yogurt is a lesson in microbiology. Generally, yogurt making involves these steps:

- Heating the milk to remove existing bacteria
- Cooling the milk to incubation temperature—the temperature at which the added cultures will grow
- Adding a "starter" culture to introduce the bacteria you want to grow in the yogurt
- Incubating the mixture for three to six hours at 42° C to 44° C
- Cooling the mixture
- Flavoring, often with fruits or honey
- Refrigerating to prevent harmful bacteria from growing

The initial heating, done until the milk develops a "skin" and stopped before the milk boils, destroys harmful bacteria that could also grow while you are incubating the good bacteria. You must cool the milk before adding the starter culture so that you don't kill the starter bacteria. The starter culture introduces the good bacteria into the yogurt. The incubation period allows these bacteria to grow and produce lactic acid. After the mixture has sufficiently fermented, cool the yogurt and flavor it. After fermentation the yogurt must be refrigerated. Otherwise, harmful bacteria may start to grow again.

Fermentation temperature needs to be carefully controlled at 42° C to 44° C. There are several ways to incubate the yogurt. If you have a commercially built incubator, the process is particularly easy. However, you can also control temperatures by incubating the yogurt in a thermos bottle, using a thermostated Crock-Pot, or using your oven. You can control temperature in the oven by putting a pan of warm water on the bottom shelf.

When producing yogurt, 2% or 4% milk is reliable; however, skim milk, powdered milk, and soy milk can also be used. We suggest that you use whole milk for the first yogurt-making attempt. Learners can then experiment with skim, powdered, or soy milk.

Extensions or variations on this activity include making bread or pretzels, kim chee, sauerkraut, cheese, bread, or root beer. They may make pickles with older recipes—some newer recipes are nonfermented. You may want to have learners experiment making yogurt with different milks, different starter cultures, and different recipes and procedures. Recipes in books or on the World Wide Web can suggest a number of avenues for experimentation.

Environmental Note

It is important to start out with ultra-clean equipment in this activity. Bacteria present on the equipment could grow during the incubation period.

Activity 9

Controversial Questions on Food Safety and Preservation

Materials Checklist

☐ Handout 9-1 (1 per learner)

☐ Access to various articles on irradiation, including those representing the industry's point of view and those critical of food irradiation, as well as research on meat safety and the meat processing industry. (Note: Newspapers, magazines, and the World Wide Web all provide information that may be useful. You may want to meet in a library for this activity.)

Approximate Time Required

☐ Research, 3-5 hours

☐ Fishbowl, 45-90 minutes

Environmental Note

Recycle all leftover paper.

What to Do in Advance

☐ Arrange for access to library, Web, or other sources for research.

Leader Notes

While there are no right or wrong answers to the question of responsibility for safe meat, discussion can provide a chance for learners to bring together what they are learning about food safety and apply that knowledge to real-life issues. So that all learners have an opportunity to make their voices heard on an issue that often elicits viewpoints that are difficult to reconcile, we suggest a fishbowl format (described below).

Key Questions

By now, learners should have developed an understanding of food preservation issues as important social and economic concerns. This activity will engage learners in a discussion of two major concerns to the public, government, and food industry groups:

- Who is responsible for safe food?
- Should irradiated food be used in our (school, club, troop, etc.) lunches?

Genetic modification of food is heating up as an issue in the United States. It has been a volatile issue in Europe for some time. An additional, or alternate, question for this activity may be one of whether the group should eat genetically modified foods.

Meat Safety

At least two sharply divergent perspectives exist on who is responsible for the safety of meat. Many food processors and others argue that problems with *E. coli 0157:H7* and other harmful microorganisms are consumer related. People and restaurants just do not know enough about keeping a kitchen clean and cooking foods properly, or are too careless about doing so. Many consumer groups argue that food contamination problems lie with processing procedures. They think people should not have to take extraordinary precautions when preparing their daily meals. People taking the former view argue that consumers are ultimately responsible for what they eat and often call for no changes in existing regulations, or for fewer regulations. People taking the second view often claim that consumers have a right to uncontaminated food and push for stricter regulation of the meat processing industry.

Irradiation

Suppose there was a food preservation process that could destroy microorganisms and enzymes, could delay the ripening of fruits and vegetables, could destroy harmful bacteria in fresh meats, would not use potentially harmful chemical preservatives, and could help reduce world hunger. Suppose that same process could extend the useful life of meats for days, berries for weeks, and some foods for years, while doing little to change the taste, nutritional value, or appearance of foods—all at a relatively low cost. According to proponents such as the USDA, FDA, many food industry organizations, and others, such a process is already in use—food irradiation.

Irradiation is a process that exposes food to radiation to weaken or destroy harmful bacteria. Food is loaded on a conveyor belt and exposed to a radioactive source for a period of time. Irradiation can greatly extend the shelf life of many foods.

Each year, up to fifty percent of the world food harvest is lost because of spoilage by microorganisms and pests.[38] Many areas of the world do not have access to refrigeration, or people cannot afford it. Often food losses are greatest in countries where economic conditions are the weakest. Thus, many world health, food, and agricultural organizations put a high priority on increased use of irradiation as a food preservation technique. Similarly, many who are concerned about increases in *E. coli*, salmonella, campylobacter, and other outbreaks of harmful microorganisms view irradiation as a way of eliminating many food-borne illnesses. For years, astronauts and cosmonauts have been using irradiated food in space. Many scientific studies show no or few harmful side effects from food irradiation.

Preserving food through radiation can be done in two ways—pasteurization and sterilization. Pasteurization uses relatively low doses of radiation; sterilization uses higher doses. Food is irradiated using cobalt-60, X rays, electron beams, or cesium-137.[39] As radiation enters the food, it ionizes some of the atoms in the food. It also alters some molecules in both microorganisms and the food by disrupting DNA and breaking some atomic bonds. The new molecules and the fragments produced are called radiolytic particles. Some of the radiolytic particles are familiar and harmless chemical compounds. Other compounds are new and unidentified. Those critical of irradiation believe that these new unidentified compounds may cause health concerns. Compounds called free radicals can be formed during irradiation. The effects of free radicals on health are controversial. Irradiated food does not become radioactive, just as a dental X ray does not make your mouth radioactive.

USDA research shows that irradiation has little effect on food composition, but opponents of irradiation challenge this claim. Some argue that irradiation creates toxins and other carcinogens, as well as destroys vitamins in foods. Little long-term research has been done on the effects of regularly consuming irradiated foods. Other opponents of irradiation focus on the radioactive waste produced, the increased possibility of nuclear accidents, and worker exposure to radiation. Others say that irradiation is a high-tech, high-cost solution to a problem that should have been prevented earlier—that preventing food contamination before it happens is more desirable than sterilizing the contaminants afterward. They argue that irradiation may encourage processors to relax current cleanliness procedures or make attempts to rescue already contaminated foods.

As with the first question, there seems to be no right or wrong answer to the question of the ultimate impacts of food irradiation. However, bringing together conflicting viewpoints and scientific evidence can be a useful process in helping learners assess risks and evaluate evidence. Again, we suggest a fishbowl format for this activity.

After the discussion, you may wish to point out that your group probably already eats irradiated foods. In the United States, spices have been preserved through irradiation since about 1985. Fruits, vegetables, pork, herbs, wheat, and potatoes are also among the 30 or so foods that have been approved for irradiation. In restaurant and cafeteria settings, or when irradiated foods are combined with other food items, irradiated products are not required to be labeled.

The Fishbowl

Fishbowls allow participants to learn about and discuss controversial questions in a nonconfrontational manner. The two issues discussed in this activity are likely to be quite controversial:

- Who is responsible for safe food?
- Should irradiated food be used in our (school, club, troop, etc.) lunches?

These questions require research, synthesizing information, and formulating recommendations. Research, particularly on the second question, should be as in-depth as time and curricular/programming needs allow.

In a fishbowl activity, part of the group gets to talk first about the issue. The rest of the group sits in a circle surrounding the people in the fishbowl. Only people inside the fishbowl are allowed to talk. People outside the fishbowl must listen. Later, the listeners get a chance to be in the fishbowl, and those who were in the fishbowl get a chance to listen.

Depending on the size of your group, you will want four to eight people to be inside the bowl. Ask learners to volunteer, or select learners to be in the first fishbowl. Structure the inner group so that you have roughly equal numbers of learners who will speak on each side of the issue. Ask the learners in the fishbowl to discuss the question while everyone else listens. Make sure all students inside the fishbowl are heard. Hold enough separate fishbowl activities so everyone gets a chance to be in the fishbowl for each issue.

Note

If you are accessing the Internet in a school setting, make sure that you are in compliance with all school, district, and state policies governing student Internet use.

As learners prepare for the fishbowl, they will find scientific evidence and numerous scientific studies cited both by supporters of irradiation and by its detractors, as well as information on safety issues. Learners will need to think critically about competing claims of the pluses and minuses of food irradiation. They will learn that sometimes they must make decisions based on incomplete and often contradictory information, and must weigh the risks and benefits of particular decisions. Handout 9-1 provides the learner with information for this activity.

If you plan to access the Internet for research, make sure you have parental permission (in writing) to do so. It is important that you closely monitor use to prevent learners from accessing sites that are off-task or objectionable.

Activity 10

Food Jeopardy!

Leader Notes

In this activity learners develop and participate in a game based loosely on the premise of the television game show *JEOPARDY!* Teams of learners develop a pool of answers and questions based on food preservation concepts and issues. They will then test their answers with other groups of learners. For example, if a game leader reads the answer, "A bacteria found in the intestines of many animals that frequently contaminates ground beef," team members would respond with the question, "What is *E. coli*?" Once a series of answers and questions has been developed, tested, and refined, learners will pool the questions, then conduct a game of "Food Jeopardy!" Food Jeopardy! should be used after learners have had a chance to explore other activities.

Key Questions

- What are important facts that everyone should know about food safety and food preservation?
- How can we share our knowledge about food preservation with others?

We suggest that you use the Food Jeopardy! game that learners develop as part of an exhibition or community service activity where learners can show the community what they have learned in this project. Such an event might be part of a local fair, display in a mall or store, school event, or other activity. You may want to team with the Extension Service. Have food safety demonstrations available. Learners may also want to try out Food Jeopardy! with other groups or classes.

Materials Checklist

☐ Handout 10-1 (1 per answer team)

☐ Timer or stopwatch (1, to keep time during game)

☐ Method of keeping and posting scores (1 for each team)

☐ Answers and questions (developed by learners; varies depending on group size)

☐ Paper and pencils for writing answers and questions

Approximate Time Required

Developing questions, 45 minutes

Testing questions, 1 hour

Revising questions, 45 minutes

Conducting game, 30 minutes

Environmental Note

Recycle leftover paper.

What to Do in Advance

☐ Copy Handout 10-1.

☐ Brainstorm ideas about groups to involve in playing the game.

Developing the Answers

Divide learners into teams for writing answers and the accompanying questions. Each team should be responsible for developing answers on a particular topic. All answers should focus on information important to food safety, threats to food safety, preservation techniques, and safe handling of food. After a team has developed its answers and questions, they should try them out on their peers, revising or discarding problematic answers.

Handout 10-1 shows some sample answer/question pairs.

At least two members of each team should have a thorough understanding of why a particular question is appropriate for a given answer. These expert members will be responsible for explaining or teaching the concept to game players.

After all answers and questions have been tested and revised, transfer them to slips of paper or an answer list. You may want to have answers on one side of the sheet and questions on the other side of the sheet. These slips or sheets will be used by the game leader in leading another group of learners in Food Jeopardy!

Logistics of Playing the Game

One learner should be the game leader. The game leader reads the answers and directs game activity. If you have a small group, you or another group leader may wish to serve as the game leader.

At least one learner serves as judge. The judge decides whether the questions are correct, times the responses, and determines which team buzzed in first. If you have a large enough group, two or three learners can act as a judging team, with one judge serving as timekeeper. If enough people are available, one learner or one learner per team should be appointed as scorekeeper. The scorekeeper keeps track of each team's points on an ongoing basis and posts points at the end of every round. Points can be posted on a chalkboard, on chart paper, or on a poster designed for the game. The remainder of learners in the group serve as experts on the questions, explaining or teaching the concepts to players, if all answers are incorrect.

The group that will play the game should be divided into two, three, or four teams, depending on the number of people available. Each team should have an approximately equal number of members. One learner in each team should be appointed as spokesperson. This person will supply the official answer for the group.

Rules of Play

Determine the number of answers you will use in the game. We suggest preparing at least 30 to 45 answers for a game involving two teams. If you have more teams, you will need a larger pool of answers. Also, adjust this number and the final point value to reflect the time available with your group of learners. This forms your pool of answers for Food Jeopardy!

Correct questions are worth 100 points.

When the answer is read, teams that think they can supply the correct question can buzz in by having the team spokesperson raise a hand. The first team to respond will have an opportunity to supply the correct question. Judges are responsible for determining which team buzzed in first.

When the judge has acknowledged that a team has "buzzed in," the team must develop a consensus question within two minutes. It is important to allow some time for learners to think about their responses, test them with others, and develop a consensus before responding.

Questions will be accepted only from the team spokesperson. Once stated, a question cannot be changed. Responses must be in the form of a question (i.e., What is ? or Who is ?). If the response is correct, the team will have 100 points added to its score. If a response is incorrect, the team will have 100 points subtracted from its score. Negative scores are possible.

Judges should keep time, starting as soon as they acknowledge that a team has buzzed in. If the team does not respond within the allotted time, it will have the point value of the answer subtracted from its score and another team will have the opportunity to respond.

If no team buzzes in after two minutes or no team answers correctly, that answer is removed from the game. The expert on that question comes forward to explain the concept briefly (two to three minutes) to game players. After the explanation, the game leader reads another answer, and the game proceeds.

The scorekeeper updates team scores after each question. Scores should be posted so that they are visible to all participants.

The game ends when all teams have scores of 1200 or above. There are no winners or losers because food safety is not a matter of winning and losing—it is a matter of everyone knowing enough to win.

If you run out of questions before all the teams get 1200 points, recycle the previous answers that were missed.

Materials Summary

Activity 1: A Survey in My Kitchen

☐ Handout 1-1 (1 per learner)
☐ Handout 1-2 (1 per learner)

Activity 2: pH, Pickling, and Osmosis

pH measurement

☐ Handout 2-1 (1 per learner)
☐ Handout 2-2 (1 per learner)
☐ Small plastic cups to spit saliva into (1 per learner)
☐ Solutions for measuring pH:
  Lemon juice (1/2 ounce per group)
  Tap water (1/2 ounce per group)
  Deionized water (1/2 ounce per group)
  Cider vinegar (1/2 ounce per group)
  Distilled vinegar (1/2 ounce per group)
  Milk (1/2 ounce per group)
  Dill pickle juice (1/2 ounce per group)
  Citric acid solution (mixed from powder) (optional)
  Ascorbic acid solution (mixed from powder) (optional)
☐ pH paper (1 vial)(Note: You can get pH paper from science supply catalogues; places that sell swimming pool supplies, and some medical, gardening, nutrition, farm, craft, and restaurant supply stores.)
☐ pH meter (optional)
  squirt bottle of deionized water (to rinse pH meter, if used)
☐ Tissues (if pH meter is used)
☐ Small plastic cups or beakers (1 for each liquid tested)
☐ Kitchen timer

Osmosis demonstration - Method A

☐ Handout 2-3 (1 per learner)
☐ Handout 2-4 (1 per learner)
☐ Sausage casing or dialysis tubing (approximately 6 inches)
☐ Pancake syrup (approximately 3 ounces)
☐ String (6 inches)
☐ Tall, narrow, clear container, such as a graduated cylinder
☐ Water
☐ Sliced dill pickles for sampling (1 for every 4-5 learners)
☐ Sliced cucumbers for sampling (1 for every 4-5 learners)

Osmosis demonstration - Method B

☐ Eggs (2)
☐ Vinegar (enough to cover eggs)
☐ Container for eggs and vinegar
☐ Water
☐ Container for water and egg
☐ Corn syrup
☐ Container for corn syrup and egg
☐ Large spoon

Activity 3: Mold, Fungus, and Bacteria

☐ Handout 3-1 (1 per learner)
☐ Handout 3-2 (1 per learner or group)
☐ Hand lens or microscopes (optional, 1 per 10 learners)
  If using a microscope:
  slides (flat and some with wells)
  slide covers (approximately 4 per learner)
  eyedroppers (7)
  distilled vinegar
☐ Pond water with mobile microorganisms in it (small amount)
☐ Copies of illustration of yeasts and molds/fungi (optional)
☐ Moldy bread (1 piece)
☐ Glass or acrylic jar with a tight lid (1 per learner)
☐ Eggs (1 per learner)
☐ Tap water

Activity 4: Dehydration

Making dehydrated food gifts

☐ Handout 4-1 (1 per learner)
☐ Food dehydrator (1 per group)(Note: Borrow a commercial one for demonstration, if possible. Directions for making your own are provided below.)

☐ Dehydrated fruits or vegetables

☐ Scales or balances for weighing fruit (approximately 1 per 12-15 learners)

☐ Wax paper (1 roll)

☐ Plastic gloves for food handling (at least 1 pair for each learner and adult)

☐ Small glass jars with lids (you may want learners to bring these from home) or small sealable bags (1 per learner)

☐ Calculators (approximately one per 12-15 learners)

☐ Large stainless steel bowl (1)

☐ Large spoon (1)

☐ Price sheet of fresh fruits and dehydrated fruits, listing either cost per ounce or cost per pound. List any fruits or vegetables you buy. If your group grows its own, compare what it costs to grow the food with what it costs at a local grocery store. (either 1 sheet, posted, or 1 sheet per learner)

Building a food dehydrator

Materials will vary with design; to build the design provided, these materials are needed:

☐ Aluminum roasting pans (2 of the one-use foil type, 16.5" x 13.5" x 3.25")

☐ Metal 16" x 10" baker's rack

☐ Lightbulb, socket (with switch), and cord or lamp-making kit

☐ Small aluminum loaf pan (the one-use foil type, 6" by 4")

☐ Binder clips (6, medium or large)

☐ Flexible wire (small pieces)

☐ Electrical tape (small amount)

☐ Small piece of hose, pipe, or other conduit for protecting electrical cord where it travels through the loaf pan

☐ Knife (for making slits in pan and cutting hole for lightbulb)

☐ Battery-operated personal fan (less than 3" in height)

☐ Thermometer

Activity 5: Canning, Pressure Cooking, and Air Pressure

☐ Pressure cooker with pressure gauge and lid (Make sure to use a modern pressure cooker with a safety valve.)

☐ 4 to 5 pounds dried pinto beans (1 batch pressure-cooked for 30 minutes; 1 batch simmered without pressure for 30 minutes)

☐ Small bowls and spoons (1 for each learner)

☐ Large serving spoon

☐ Napkins or clean rags

☐ Plastic gloves for food handling

☐ Home canning supplies for demonstration: racks, jars of various sizes, lids with seals and rings

☐ Samples of previously canned foods

☐ Can opener

☐ Blindfold

☐ Tongs

☐ Ice

☐ Aluminum pop cans (empty; at least 1 per learner)

☐ Hot plate or burner

☐ Large tongs

☐ Tray or bowl of cold water

Activity 6: Refrigerating and Freezing Foods

☐ Handouts 6-1 and 6-2 (1 per learner; Handout 6-2 is optional)

☐ Freezer wrap (white paper)

☐ Plastic wrap

☐ Wax paper

☐ Aluminum foil

☐ Plastic baggies

☐ Fasteners—tape, rubber bands, twist ties

☐ Marker pen

☐ Storage containers:

plastic containers and lids

glass jars and lids

ceramic bowls and plastic wrap

plastic bags

☐ Straws

☐ Netting bags of chopped onions (1 per learner)

☐ Leftover foods (several types) (Note: To avoid waste and lessen transportation problems, you may want to use pictures or descriptions rather than actual food items.)

Activity 7: Can You Find the Food Additives

☐ Handout 7-1 (1 or more per learner)
☐ Handout 7-2 (optional, 1 per learner)
☐ Handout 7-3 (optional, 1 per learner)
☐ Laundry basket of common processed foods (empty packages and cans are fine)
☐ Additional resources on food additives and potential side effects. (Note: Useful books on food additives include *The Food Additives Book*, Nicholas Freydberg and Willis A. Gortner, 1982; *A Consumer's Dictionary of Food Additives*, Ruth Winter, 1994; *Food Additives: A Shopper's Guide To What's Safe & What's Not*, Christine H. Farlow, 1997; *Additives (Food Facts)*, Rhoda Nottridge, 1993; and medical guidebooks.)
☐ Internet access

Activity 8: Fermentation—What a Cheesy Idea!

Capturing wild yeast

☐ Glass jars (1 per learner—have learners bring these from home)
☐ Pieces of old stocking material (1 pair of old panty hose should make enough lids for a fairly large group of learners)
☐ Rubber bands (1 per learner)
☐ Flour (plan on 1 cup per learner to catch yeast; 1 cup per learner to feed yeast)
☐ Water
☐ Measuring cup (to measure flour and water)

Making yogurt

☐ Milk (1/2 cup per learner or team)
☐ Measuring cup to measure milk (1 per learner or team)
☐ Plain commercial yogurt with active cultures (Note: The yogurt should not contain gelatin; read the label carefully!) (1 carton per learner or team)
☐ Saucepans for heating milk (1 per team, or teams can share)
☐ Stirring spoons (1 per learner or team)
☐ Stove or other heat source for heating milk
☐ Thermometers for monitoring temperature—candy thermometers work well (1 per learner or team)
☐ Method for incubating yogurt (commercial yogurt makers, thermos bottles, oven and glass jars, Crock-Pot®)
☐ Spoons for tasting (1 per learner)

Activity 9: Controversial Questions on Food Safety and Preservation

☐ Handout 9-1 (1 per learner)
☐ Access to various articles on irradiation, including those representing the industry's point of view and those critical of food irradiation, as well as research on meat safety and the meat processing industry (Note: Newspapers, magazines, and the World Wide Web all provide information that may be useful. You may want to meet in a library for this activity.)

Activity 10: Food Jeopardy!

☐ Handout 10-1 (1 per answer team)
☐ Timer or stopwatch (1, to keep time during game)
☐ Method of keeping and posting scores (1 for each team)
☐ Answers and questions (developed by learners; varies depending on group size)
☐ Paper and pencils for writing answers and questions

Food Preservation

Handout 1-1

Approaches to Food Preservation

If early humans had not developed methods of preserving foods in times of plenty to use in times of want, our modern way of life would not be possible. Long before they had the scientific knowledge to understand how microorganisms can cause food spoilage, our ancestors, through observation and experimentation, developed ways to slow or prevent food from spoiling. You probably know that people have been drying and fermenting foods for thousands of years. You may not have known that such modern techniques as freezing, freeze drying, refrigeration, and using food additives have been used since ancient times as well.

There are six basic approaches to preserving food, all of which focus on preventing harmful microbes from doing damage. Many are used in conjunction with one another. See how many of these you can locate in your kitchen.

1. **Preventing or minimizing the entry of microorganisms into food**. Aseptic packaging such as drink boxes for juices or milk is an example of this approach.

2. **Removing microorganisms through washing or other physical techniques, or through adding antimicrobial chemicals**. Many of the additives you find listed on food labels are antimicrobials, but antimicrobial chemicals are also found naturally in some foods. Garlic, onion, leeks, and many spices, for example, contain natural antimicrobials. Antimicrobial properties often make these foods popular in folk medicines as well.

3. **Destroying microorganisms with heat or chemicals, as in canning or pasteurization**.

4. **Destroying microorganisms through irradiation**. Irradiation is used to preserve many spices. With food poisoning a growing threat, irradiation may become more widely used in preserving meats, fruits, vegetables, and berries in the future.

5. **Slowing or inhibiting the growth of microorganisms through freezing, drying, refrigeration, etc**.

6. **Fermenting or adding desirable microorganisms to compete with undesirable microorganisms**. Yogurt, cheeses, pickles, and kim chee are ancient examples of preservation through fermentation. Very recent agricultural research is exploring the technique of using good microorganisms to crowd out bad microorganisms on chickens, to reduce the incidence of salmonella.

Food Preservation

Handout 1-2

A Survey in My Kitchen

Take a survey of the foods in your kitchen. Use the following sheet to record each food, spice, condiment, or drink item, and how you think the item has been preserved. Predict how long you think the item will last before it becomes unfit to eat.

Remember to record the foods in your refrigerator and freezer, as well as in your cabinets.

Some foods may be preserved by multiple methods. Record all the ways that you think have been used.

Food, spice, or condiment	***How preserved?***	***Predict how long it will last***

Food, spice, or condiment	***How preserved?***	***Predict how long it will last***

Food Preservation

Handout 2-1

pH Values

Liquid	pH Measurement	Acid, Base, or Neutral
lemon juice		
tap water		
deionized water		
cider vinegar		
distilled vinegar		
milk		
dill pickle juice		
citric acid solution		
ascorbic acid solution		

Liquid	**pH Measurement**	**Acid, Base, or Neutral**
saliva:		
Learner 1		
Learner 2		
Learner 3		
Learner 4		
Learner 5		
Learner 6		

Food Preservation

Handout 2-2

Acid, Base, or Neutral?

pH is an important concept in food preservation and other areas of chemistry. The greater the acidity of a substance, the lower the pH value. Usually pH measurements are taken for liquids. A measurement can range from 0 (very, very acidic) to 14 (very, very basic). A pH of 7 is neutral. Acids are tart and tangy. Bases are slippery like soap.

Around your house, you will find that most cleaning agents are basic (pH of 8-14). In your refrigerator, you will find that most foods are acidic (pH of 2-7). Here are some examples of pH values for foods:

Food	**pH**
Plums	2.75
Gooseberries	2.75
Green peas	6.50
Dill pickle juice	*

**Measure this value yourself!*

Have you ever heard of "acid indigestion?" This is caused by low pH foods, plus low pH from stomach fluids (bile, acids to break down foods). Too much acid can cause a burning feeling in your stomach. As some people get older they cannot tolerate eating large amounts of low pH/acidic foods (pizza, Coke, etc.).

pH Scale

strong acid				acid				neutral			base			strong base
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14

Food Preservation

Handout 2-3

Osmosis

Osmosis is the movement of molecules (particles) across a semipermeable membrane so that the concentration of liquids on both sides of the membrane is equal. A semipermeable membrane has very, very small (microscopic) holes on it like the skin of a vegetable, fruit, person, hot dog, balloon, etc. Some molecules are small enough to go through these holes from one side to the other. Other molecules are too larege to go through.

Example: Fill a sausage casing (semipermeable membrane) with pancake syrup (large molecules of sugar). Dip the filled casing in water (small molecules). Since water molecules are smaller than sugar molecules, the water molecules can pass through the casing. They will move into the casing and dilute the pancake syrup inside. In this case the syrup cannot move out of the casing.

In this demonstration we started with a measured amount of water. Over time, some of the water molecules will go into the casing. When you lift out the casing, you will see that the level of water in the cylinder will be less than it was initially because some of the water has migrated into the casing. The casing will be fuller than it was at first because it now contains water that migrated in.

Handout 2-4

Questions to Ponder and Discuss . . .

1. Do any of the pH readings for the liquids surprise you?

2. Why is the pH of your saliva significant to the topic of food preservation?

3. What differences do you observe between the pickle and the cucumber?

4. Did water flow into or out of the cucumber as it underwent osmosis to turn into a pickle?

5. If the cucumber were just sitting in water and sealed in a jar, would it be as safe to eat as a pickle?

6. Most pickle recipes specify that there should be at least as much vinegar as there is water. Why is this ratio important?

7. What are some advantages and disadvantages of pickling foods?

Food Preservation

Handout 3-1

Preparing Your Egg

Ten days before the workshop: Your special assignment is to prepare one hard-boiled egg. Prepare your egg by boiling it and storing it according to the directions checked on this sheet.

__________ store in tap water without refrigeration

__________ store in tap water with refrigeration

__________ store in distilled vinegar without refrigeration

__________ store in distilled vinegar with refrigeration

__________ store without liquid with refrigeration

__________ store without liquid in a sealed container in the freezer

Directions: To hard boil an egg, bring water to boil, gently drop in the egg, and simmer for 12-15 minutes. Run cold water over it to cool. Carefully peel off the shell. Put your boiled egg in a clear glass or acrylic jar with a lid that fits tightly. Pour tap water, distilled vinegar, or no liquid in the jar before you place the lid on the jar and place it in the appropriate location. Your jar should be labeled with your name and a description of how the egg was processed. Please do not open the container because this lets more microorganisms in. Bring the egg in its container to the workshop.

Remember to bring in your egg on the appropriate day!

Handout 3-2

Microorganisms and the Eggs

Directions: Using a scale of 1 (bad, not edible) to 10 (excellent, edible) rate each egg by appearance, smell, texture, and taste (if it is one of the three edible types of eggs). You may also give descriptions for the appearance (slimy, green, cloudy, etc.)

Type of Egg	Visual Appearance	Microscopic Appearance	Smell	Texture	Taste
tap water without refrigeration					Do not taste
tap water with refrigeration					Do not taste
distilled vinegar without refrigeration					
distilled vinegar with refrigeration					
no liquid with refrigeration					Do not taste
no liquid in freezer					

Compare the fuzz on the eggs to the fuzz on the moldy bread. What does the mold on bread look like under a hand lens or microscope? Draw a picture to illustrate.

Look at the pond water under a hand lens or microscope. Do you see any microorganisms? What happens to them after you add vinegar? Why do you think this might have happened?

Food Preservation

Handout 4-1

Dehydration

Problem: How much moisture is lost when apples are dehydrated?

1. Weigh 10 slices of dried apples (in grams) and record the mass.

   Mass of 10 slices of dried apples __________ g

2. Weigh 10 slices of fresh apples (in grams) and record the mass.

   Mass of 10 slices of fresh apples ___________ g

3. Determine the difference between the mass of the dried apples and the mass of the fresh apples. The difference between the two is the mass of water lost during the dehydration process. What is the percentage difference in mass between the fresh and the dehydrated fruits?

   Mass of water lost ___________ g

   Percent difference in mass ________ %

4. If you were going to dry 75 slices of fresh apples, how much water would you expect to lose? What mass would you expect the 75 slices of dried apples to have?

   Water lost by 75 slices of dehydrated apples _____________ g

   Predicted mass of 75 slices of dehydrated apples _____________ g

5. If you were drying 25 pounds of fresh apples, how many pounds of dried apples would you expect to produce? Could you carry those slices easily on a long hike?

   Pounds of dried apples produced _________________________ lbs

Comparing Prices

A five-pound bag of fresh apples costs $3.00. A six-ounce bag of dried apples costs $1.50. What is the price of one pound of each?

There are 16 ounces in a pound.

One pound of fresh apples costs ________________

One pound of dried apples costs ________________

Handout 4-2

A Homemade Dehydrator

Materials Needed

The homemade dehydrator we designed uses the following:

Aluminum roasting pans (2 of the one-use foil type, 16.5" x 13.5" x 3.25")

Metal 16" x 10" baker's rack

Lightbulb, socket (with switch), and cord or lamp-making kit

Small aluminum loaf pan (the one-use foil type, 6" x 4")

Binder clips (6, medium or large)

Flexible wire (small pieces)

Electrical tape (small amount)

Small piece of hose, pipe, or other conduit for protecting electrical cord where it travels through the loaf pan

Knife (for making slits in pan and cutting hole for lightbulb)

Battery-operated personal fan (less than 3" in height)

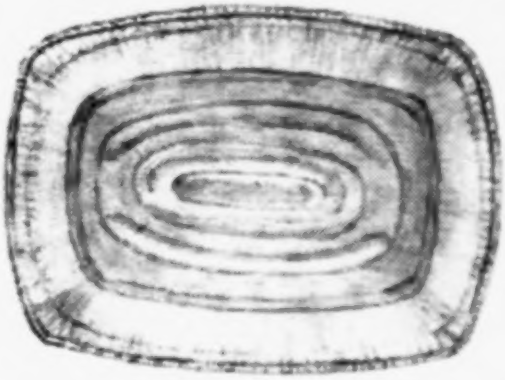
Thermometer

Brief Description

The roasting pans form the body of the dehydrator. Heat is supplied by the lightbulb. The baker's rack holds the drying food. The small loaf pan keeps moisture from hitting the lightbulb. Wire is used to fasten the loaf pan to the baker's rack. Binder clips hold the two halves of the dehydrator together when in use; unclip to allow access. The small fan provides air circulation. Slits in the top loaf pan allow moisture to escape.

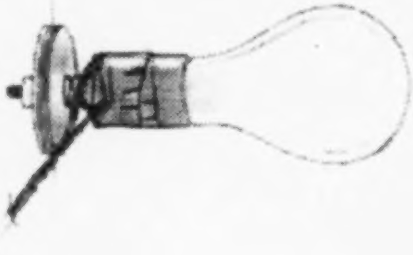
Cost: Approximately $10.00

Temperature control: Experiment with lightbulbs of different wattages to establish correct temperatures. We found a 40-watt bulb worked well for drying apples. Use a candy or meat thermometer to monitor temperature, and adjust accordingly.



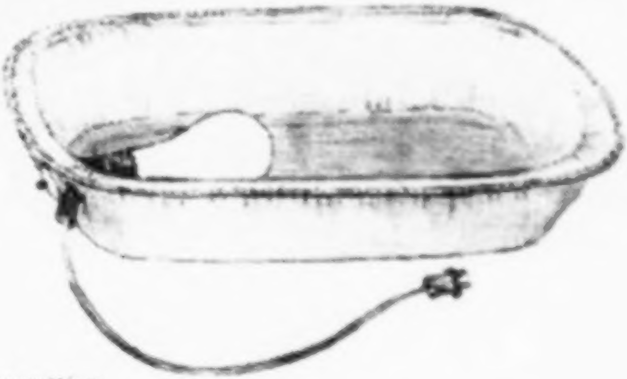
Base of the dehydrator: One of the large roasting pans will form the base of the dehydrator. Cut a small hole in the middle of a short side of the dehydrator.

The hole should be just large enough to mount your lightbulb base and allow the switch to turn.



Mount the lightbulb assembly. You may want to use large washers on either side of the foil pan to stabilize the assembly.

Make another small hole in the pan, near your bulb base for the electrical cord. Put a small piece of pipe or tubing into the hole. Run the electrical cord through the pipe or tubing so that it will not chafe against the rough metal edges of the pan. Secure the pipe or tubing with electrical tape

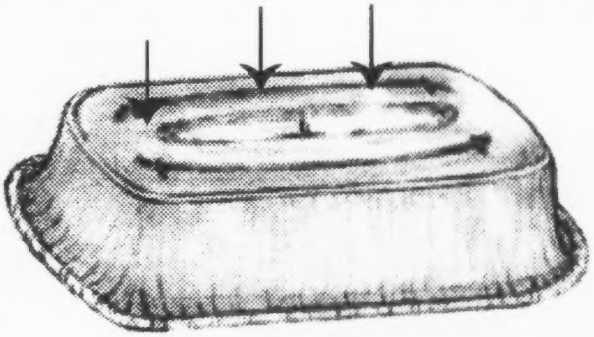


Next, you will connect the cord to the lightbulb assembly.

Run the electrical cord through the tubing and attach to the posts in the light socket. Make sure that your wires are connected firmly and are not shorting out. Use electrical tape to securely cover any exposed metal.

Have your leader check your electrical connections for safety.

Test your electrical connections by putting in a lightbulb, plugging in the cord, and turning on the light.

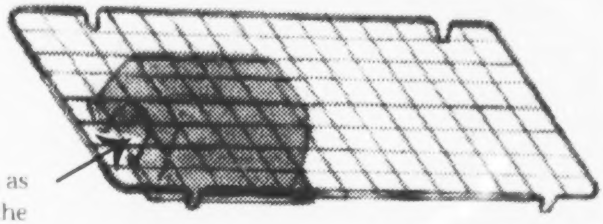


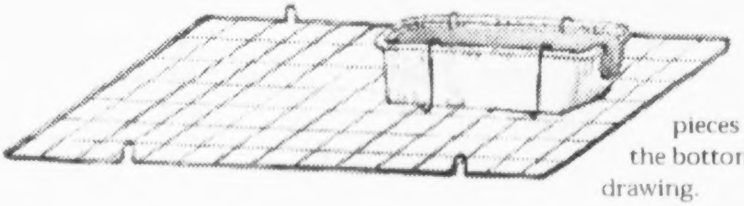
Dehydrator tray and lid

The second roasting pan will serve as your dehydrator lid. Using a knife or can opener, punch several small slits in the bottom of the roasting pan. The slits will allow moisture to escape from the dehydrator.

The baker's rack serves as a tray for the food. The small loaf pan will be attached to the bottom of the tray to keep moisture from hitting the lightbulb and breaking it.

Cut a semicircle in the end of the loaf pan, as indicated, so that the pan will fit snugly over the lightbulb.

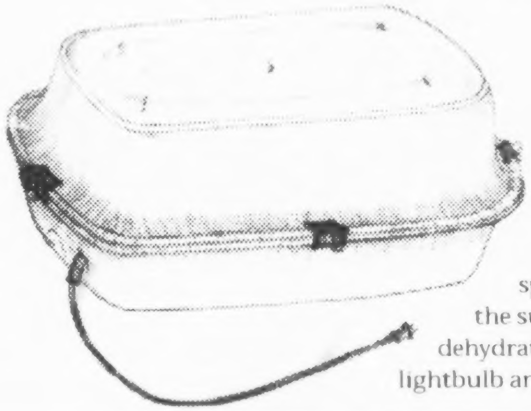


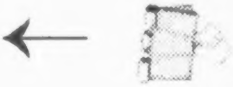


Using four paper clips or short pieces of wire, attach the loaf pan to the bottom of the tray, as indicated in the drawing.

Assembling the completed dehydrator: Lay the baker's rack atop the dehydrator base. Make sure that the loaf pan attached to the rack is placed over the lightbulb so as to prevent any drips from hitting the bulb.

Put the food to be dehydrated on top of the baker's rack.





Put the lid on top of the pan. Fasten the assembly together with binder clips, as indicated in the diagram.

Place the dehydrator in a secure spot where the heat it produces will not damage the surface or catch anything on fire. Keep your dehydrator away from moisture. Plug it in. Turn on the lightbulb and begin drying your food.

Evaluating the Design

Pluses

- This dehydrator is relatively low cost to build.
- Dehydrator goes together quickly and requires minimal construction.
- All parts are readily available at a moderately sized grocery store.
- The dehydrator will dry small quantities of fruits and vegetables fairly quickly.
- Cleaning up the dehydrator is easy.

Minuses

- It is not designed for large quantities or long-term use.
- Aluminum pans can be crushed easily.
- It may not be very energy efficient—no insulation and batteries on the fan can run down quickly.

Safety Concerns

- Attaching the electrical cord to the socket requires making electrical connections. These must be carefully checked to ensure they have been done properly and have been shielded so that no one will get shocked.
- The electrical cord running through the aluminum pan could eventually get frayed, creating an electrical hazard.
- The dehydrator could easily be knocked off a counter top, breaking the lightbulb. Careful placement is necessary.
- The dehydrator can get hot. Care must be taken when touching metal surfaces after the dehydrator has been running.

Food Preservation

Handout 4-3

Our Dehydrator Plans

Materials Needed

____

____

____

____

Description of Dehydrator

__________ is used to supply heat.

__________ provides for circulation.

__________ eliminates moisture.

Sketch of Dehydrator

Assessing Our Design

Pluses______________________________

____

____

____

Minuses______________________________

____

____

____

Safety concerns______________________________

____

____

____

Food Preservation

Handout 6-1

Get the Burn Out

Wrapping to Prevent Freezer Burn

Freezer burn happens to many foods (meats, vegetables, breads, fruits) that are stored in the freezer. If the foods are not wrapped airtight, air from the freezer circulates around the exposed food. Over a period of time, air dries out the food, taking away its natural flavors and moisture, and giving it a very stale, yucky taste and smell. Often the appearance is changed, too. Freezer-burned chicken may look yellow or gray instead of pink. The texture may be grainy. Sometimes you can salvage the affected food by cutting away the freezer-burned area.

The best thing to do about freezer burn is to *prevent* it from happening by wrapping the foods airtight (so that air cannot get to the food). Foods that are frozen in liquids (strawberries in juice or syrup, chicken in chicken broth, etc.) are protected better from freezer burn because dry air in the freezer cannot circulate through the liquid (it may just affect the top of the food or liquid).

Instructions

Take a small bag of chopped onions and pretend that this is a chunk of ground hamburger that you are going to store in the freezer. Use any of the wrapping products (but no more than 3 to 5 kinds) to wrap the bag of onions. Label the wrapped onions with your name and what materials you used for wrapping. Set the wrapped onions together and move about 10 feet away in a group. Ask someone to be the *courier*. The courier selects an onion sample and brings it to the other learners. On a scale of 1 (no odor) to 10 (big odor), record which samples have an odor, and, by agreement, assign an odor number to it. Record this odor number on the sample.

From your observations, your group should be able to answer the following questions:

Did some onion samples have stronger odors than others?

How and with what were the strong-smelling samples wrapped?

How did the tightness of the wrap relate to the degree of the odor?

What is freezer burn? How does this activity relate to freezer burn in foods?

What are the advantages of each type of wrap that you can use?

What is the purpose of wrapping the foods before freezing?

Look at a variety of leftover foods and determine which types of containers should be used to store them in the refrigerator or freezer.

Using what you know about frozen foods, your group should create a list of tips that you would use for food storage in the refrigerator and in the freezer. Compare your tip sheet to those of other groups.

Food Preservation

Handout 6-2

Tip Sheet on Food Storage

Refrigerating Foods

1. Choose a container that is close to the same size as the amount of food to be stored. *Do not* put a small amount of leftovers in a large container. Extra air means extra bacteria and mold. The same goes for choosing freezer containers—extra air means more freezer burn.
2. It is safe to store most leftovers 3-4 days in the refrigerator. After that the growth of mold and bacteria on the food could cause illness.
3. If you use see-through lids or clear wrap on your containers, you'll be less likely to forget about them and let them go bad. Another tip is to label the foods, including the date they were put in the refrigerator.
4. In your refrigerator, set aside one section where you always put the leftovers. That way you won't have to hunt all over for them.
5. Never use eggs that are cracked or open. Cracks could let in harmful bacteria. Throw these eggs out.
6. If you see mold or bacteria on foods, throw out all of that food.
7. To prevent high-fat foods (seeds, nuts, oils) from turning rancid, store them in the refrigerator or freezer. Other foods that may become infested with bugs (whole wheat flour, cornmeal) can also be stored this way (the bugs will not survive the cold temperatures).
8. If you have room, store potatoes in the refrigerator. Keep them dry. This will inhibit the growth of potato eyes.
9. Fresh meats (chicken, lamb, pork chops, beef) can be stored in the refrigerator for 1-2 days before cooking. Don't store fresh fish very long—cook it immediately. Uncooked cured meats (bacon, ham, sausage) can be stored up to 5 days. Hot dogs and smoked meats can be stored for more than a week. All of these meats can be stored in the freezer for several months.
10. Chunky foods (like cheese, leftover meat, baked potatoes) should be stored by wrapping tightly in clear plastic wrap or bags. Other wraps (wax paper, freezer paper, aluminum foil) do not fit as tightly and allow air to get to the foods. Plastic containers also would have extra air in them to affect the flavor or moisture of the food.

Leftovers

1. The safest way to reheat leftovers is to bring them to the boiling/simmering point for 10 minutes. This is also good advice for reheating anything that has been home canned or commercially canned.
2. Consider eating your leftovers the next day. Another tip is to have "leftover night"—an evening meal where you eat all the leftovers from the previous 3 days.
3. Some leftovers can be used to make main dishes. To use vegetables, hamburgers or other meats, noodles, mashed potatoes, rice, etc.,

   a. add some broth and seasonings, then simmer to make a nice soup

   b. add a can of creamed soup, then simmer and serve over biscuits

   c. add eggs to make omelets
4. Chopped onions can be frozen. Use the onions in any quantity when you need them.

Freezing Foods

1. Most glass jars with tight-fitting lids can be used to freeze liquids (broth, juices, soups). Make sure you leave about 1/2" to 1" of air in the jar to allow for the contents to expand while freezing. This way the jar will not break. Be careful when thawing jars of frozen foods—don't run hot water over the jar or the temperature change could cause it to break. If you defrost frozen foods in the microwave, cook them immediately.
2. Egg whites (left over from using egg yolks for puddings, sauces, baking) can be frozen in a jar. Thaw them out slowly to use in meringues and cakes.
3. When using plastic bags for freezing, squeeze out all the air and seal the opening tightly by tying it in a knot or using a twist-tie. Another method is to use a straw to suck out the air, then close securely.
4. When using plastic containers for the freezer, choose ones that have flat tops and bottoms and straight sides. Lids with depressions in them help in keeping the containers stacked on top of each other.
5. Do not put hot or warm foods in the freezer. This may cause frozen foods nearby to partially thaw out and refreeze.
6. Foods that are frozen quickly and stored at low temperatures will keep better, longer. Freezing at 0° F is better than freezing at 20° F.
7. Meats can be safely thawed in the refrigerator over several days. Speeding up the thawing by setting out the food at room temperature or soaking in warm water can cause bacteria to grow in the food and cause illness. Never defrost food at room temperature!

Food Preservation

Handout 7-1

Chemical Additives

Name of food: ______________________

Ingredient	Chemical additive? (yes or no)	Function of the additive	Any potentially harmful side effects?
1.			
2.			
3.			
4			
5			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
13.			
14.			

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Food Preservation

Handout 7-2

Sample Foods with Chemical Additives

Food Item	Preservative/additive
pancake syrup	sodium benzoate sodium hexametaphosphate
Caesar salad dressing	calcium disodium EDTA
red wine	sulfites
processed cheese food	sorbic acid
instant oatmeal	sulfur dioxide sodium sulfite sodium bisulfite
crackers	ammonium sulfate calcium sulfate
flavored gelatin	disodium phosphate
bouillon cubes	BHA BHT propyl gallate citric acid propylene glycol
hot dogs	sodium nitrite
canned shrimp	sodium bisulfite
frozen yogurt	polysorbate 80
butter substitute	sodium benzoate potassium sorbate

Food Preservation

Handout 7-3

Some Functions of Food Additives

Antimicrobials prevent growth of molds, yeast, bacteria.

Emulsifiers bind ingredients, keep foods from separating, and provide a consistent texture, and thicken foods. For example, eggs help bind cake. Some emulsifiers include pectin, xanthan gum, lecithins, and dextrins.

Stabilizers bind ingredients and help make textures smooth and uniform. For example, locust bean gum helps make ice cream smooth.

Antioxidants are chemicals that inhibit foods from reacting with oxygen in the air, and thus from going rancid, browning, or developing black spots. Lemon juice, which contains citric acid, is often used as an antioxidant to prevent fresh fruits from browning.

Leavening agents are chemicals that enable baked goods to rise or that speed up the rising process. Generally, leavening agents produce acids when heated. The acid then reacts with baking soda, which generates gases inside the food.

Preservatives are antimicrobials that prevent spoilage or infestation by insects. For example, vinegar, which is acidic, destroys many harmful microorganisms and helps pickles, salad dressings, and many other foods last longer.

Flavoring agents are substances that add or enhance flavor in food.

Coloring agents help make foods look more appealing or more consistent in color.

Humectants help foods retain moisture. Glycerine is an example of a frequently used humectant.

Bleaches are used to give a white color to some foods, such as flour or rice.

Acids, bases, and buffers are used to control pH and adjust the taste of foods.

Nutrients such as vitamins, minerals, and iodine are added to foods to increase their nutritional value or replace nutrients lost in processing.

Definitions are adapted from sources including

Merriam-Webster's Dictionary

"A Fresh Look at Food Preservatives," J. E. Foulke, 1993

"Food Additives," Center for Food Safety and Applied Nutrition, 1992

"Food Additives," U.S. Department of Agriculture, 1994

Food Preservation

Handout 8-1

Making Your Own Yogurt

CAUTION

Safety Note: Before beginning this activity, wash your hands and all the equipment thoroughly with soap and water. Your leader or teacher may ask you to rinse all equipment with boiling water before using or to use other cleanliness measures as well.

Yogurt making is not just following a recipe, it is microbiology, developed in prehistory. In this activity you are not just making yogurt, you are destroying bacteria, adding bacteria, and growing bacteria. You are doing biotechnology, making microorganisms work for you to produce a product.

Measure 1/2 cup of milk into your saucepan. Heat the milk to 161° F and hold it at this temperature for 15-seconds, stirring continuously. (Hint: Don't let the thermometer touch the bottom of the pan. If it does, it will give a false reading.) The milk will develop a "skin." Do not let the milk boil. Heating destroys harmful bacteria that might be in the milk or on the container.

Cool the milk to 115° F. (You may want to place the saucepan in an ice-water or cool-water bath to speed the cooling process. Just make sure the water doesn't get into the milk!) Make sure the milk cools sufficiently. If you go on to the next step too quickly, you will kill off the bacteria you want to grow.

Add 1/2 container of plain commercial yogurt to the milk. You are adding a "starter culture" or introducing "good" bacteria to the yogurt. Mix the yogurt and milk thoroughly.

Using the method your leader describes, incubate the yogurt at 115° F for 4 to 8 hours. Incubation allows the good bacteria to grow. As they grow, they digest lactose in the milk and change it into lactic acid—the process of fermentation. The longer you let the mixture ferment, the more sour it will be.

It is important to maintain a warm environment for the yogurt during the incubation period because the starter bacteria need a warm environment to grow. If the temperature is too hot, the bacteria will die. If it is too cold, they will not grow.

The yogurt is finished when it slides away from the container in one lump when tilted. This yogurt won't be as thick as that you purchase in stores. Many commercial producers use additives, such as gelatin, to thicken their yogurts.

Taste your yogurt before adding any fruits or sweeteners. Experience the sourness from the lactic acid. Don't you enjoy knowing why it tastes the way it does!

Food Preservation

Handout 9-1

A Fishbowl on Two Hot Topics

You and your teammates will be exploring controversies about two food preservation and safety issues—responsibility for meat safety and irradiation as a food preservation tool. You will do this in a fishbowl format.

A fishbowl is an activity where only part of the group gets to talk at one time. The rest of the group sits in a circle surrounding the people in the fishbowl. Only people inside the fishbowl are allowed to talk. People outside the fishbowl must sit silently and listen. Later, the listeners get a chance to be in the fishbowl, and those who were in the fishbowl get a chance to listen.

In your fishbowl, you will discuss these two questions:

> *Who is responsible for safe meat?*
>
> *Should irradiated food be used in our (school, club, troop, etc.) lunches?*

Some of you will argue in favor of processing plant responsibility. Others will argue for consumer responsibility. Some will favor using irradiation to preserve foods. Others will be opposed to the issue. You will need to do some research on the issues. Then, bring your information together in a discussion called a fishbowl. You should be prepared to present all sides of the question and to back up your opinion with evidence.

Prepare your case carefully. You will need to explore information about the perceived effects—positive and negative—of using irradiation to preserve foods, then bring this information together to produce a presentation or theory that will convince others that they should follow your advice.

Here are some places to begin your research:

- Consumers International, The Center for Science in the Public Interest (consumer groups that focus on nutrition and food safety)
- The Foundation for Food Irradiation Education, a radiation industry group, has numerous articles and publications on the issue
- The American Dietetic Association

Newspapers, popular magazines, health-related magazines, and the World Wide Web are good sources for information on these topics. Just make sure you critically examine the information you find!

Food Preservation

Handout 10-1

Some Sample Answers and Questions for Food Jeopardy!

These are some sample answers and questions. The answers and questions that you develop should have a similar format and level of complexity.

Answer	Question
These bacteria inhabit the intestinal tracts of humans and animals, suppress many harmful bacteria, and produce vitamins. Some strains can be deadly.	What is *E. coli*?
Because so many eggs are contaminated by this organism, it isn't safe to eat ice cream made with raw eggs.	What is salmonella?
40 degrees Fahrenheit or less.	What should be the temperature maintained by a refrigerator?
This food preservation technique is used for foods as varied as pickles, cheese, and sausage.	What is fermentation?
Used to preserve bacon, these compounds can change into carcinogens if you cook the meat at too high a temperature.	What are nitrates?
This type of food should be refrigerated immediately after serving to remain safe.	What are meats?
This technique works to preserve food by adding beneficial bacteria and eliminating harmful bacteria.	What is fermentation?
This problem is caused by air attacking frozen food, drying it.	What is freezer burn?

A technique used to preserve spices, it has been suggested as a way to eliminate food poisoning problems in meat, yet many oppose it.	What is irradiation?
An appliance that cooks food much faster than a saucepan and is used in home canning.	What is a pressure cooker?
Food with visible slime, off-odors, or soft moldy food.	What are some foods that should be tossed out? Or, what are some foods that should not be eaten?
Hamburger must be cooked to this temperature to destroy any *E. coli* present.	What is 161°F?
This popular food preservation technique can preserve hamburger for 3 to 4 months, but it has no effect on *E. coli*.	What is freezing?
pH = 7	What is the pH of a neutral solution?
Used in pickling, this process is the reason that overfertilized lawns dry up and that sea urchin eggs burst when placed in fresh water.	What is osmosis?
Used to preserve many jams and fruits, this process also is sometimes used in preserving hams.	What is sugaring?
This method of preserving food was developed in the eighteenth century and is now one of the most popular and cost-effective preservation methods.	What is canning?
Low acidity or high pH foods are not safe to can at this pressure.	What is atmospheric pressure? Or, what is one atmosphere?
This thoroughly modern food preservation technique was also used by our ancestors to preserve mammoth and other meats.	What is refrigeration? Or, what is freezing?

This chemical has been used as a food preservative since ancient times, and its importance is reflected in many words and sayings.	What is salt?
Beverages produced by this technique were often consumed in ancient times because they were safer than the available water supply.	What is fermentation?
The process of using X rays, cobalt-60, cesium-137, or electron beams to preserve foods.	What is irradiation?
Pastas, corn, beans, raisins, and many fruits are preserved using this technique.	What is dehydration?
This technique uses beneficial bacteria to prevent harmful bacteria from spoiling food.	What is fermentation?
Sourdough bread, kim chee, yogurt, root beer, and cheese are examples of foods preserved using this technique.	What is fermentation?
By removing water from food using this technique, microbes can no longer multiply and enzymes can't do their work.	What is dehydration?

Food Preservation

Notes

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3. "Native American History of Corn" and Salvador, "Maize."
4. Humboldt Sausage Company, *History of Sausage Making.*
5. Chung, "Kudos to Kimchi."
6. Caporeal, "Ergotism."
7. Fabricant, *History of Canning;* "History of Food Preservation"; and Canned Food Information Service, "Landmarks in the History of Food Canning."
8. Centers for Disease Control and Prevention, *Food and Water.*
9. Council for Agricultural Science and Technology, *Foodborne Pathogens.*
10. Todd, "Preliminary Estimates."
11. U.S. Food and Drug Administration Center for Food Safety and Applied Nutrition, *"Bad Bug Book"* (hereafter cited as *"Bad Bug Book"*).
12. Ibid.
13. Snyder, *"Safe Hands" Wash Program.*
14. Medical Mycology Research Center, *Medical Mycology Directory;* and "Fungus."
15. Kendrick, *Fifth Kingdom.*
16. *"Bad Bug Book."*
17. Grimes, *The Cell.*
18. Waggoner and Speer, "Bacteria"; and Cano and Borucki in *Science.*
19. *"Bad Bug Book."*
20. U.S. Department of Agriculture Food Safety and Inspection Service, *HACCP Implementation.*
21. *"Bad Bug Book."*
22. Ibid.
23. Ibid.
24. Ibid.
25. ADAM Software, "Skin Abscesses."
26. Mayo Foundation for Medical Education and Research, *Antibiotic Resistant Bacteria.*
27. *"Bad Bug Book."*
28. Ibid.
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30. Biddle, Shay, and Miller, *Postharvest Pathogen Reduction* and SLACK, "Identify the Parasite."
31. MacKenzie and others, "Massive Outbreak."
32. *"Bad Bug Book."*
33. Bell, *Dry Store.*
34. Brewer, "Preserving Squash and Pumpkin."
35. Roller, *Natural Antimicrobial Systems;* Roller, "Novel Combinations"; Dillon and Board, *Natural Microbial Systems;* and Society for General Microbiology, *Fifty Years of Antimicrobials.*
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37. Steinkamp, *Art of Cheesemaking.*
38. National Research Council Commission on International Relations, *World Food* and National Research Council Board on Science and Technology for International Development, *Postharvest Food Losses.*
39. U.S. Department of Agriculture Food Safety and Inspection Service, "Irradiation of Meat"; Andress, "Food Irradiation"; and "Irradiation: How It Works."

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